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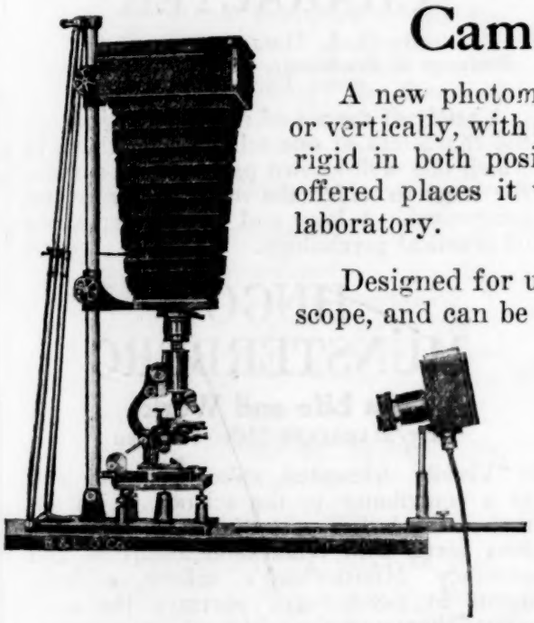

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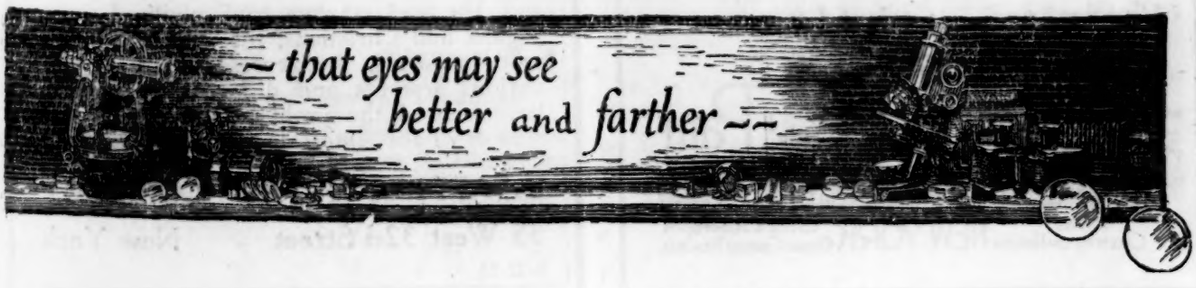

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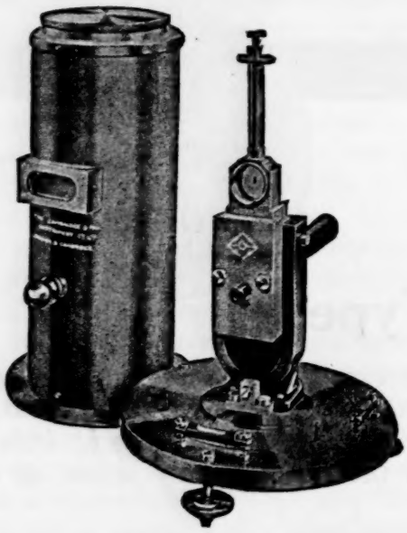

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SCIENCE

VOL. LVI DECEMBER 15, 1922 No. 1459

The Trend of Avian Populations in California: DR. JOSEPH GRINNELL 671

Are Permanent Disturbances of Equilibration inherited? DR. C. R. GRIFFITH 676

The Usefulness of Analytic Abstracts: DR. GORDON FULCHER 678

Scientific Events:

Conservation of the Resources of the Pacific; The University of Wyoming and Dr. Nelson; The Industrial Division of the American Chemical Society; The Union of American Biological Societies; Hotels for the Boston Meeting 680

Scientific Notes and News 682

University and Educational Notes 686

Discussion and Correspondence:

Glaciation in the Cordilleran Region: J. T. PARDEE. *Effects of Copper Wire on Trees:* DR. GEORGE B. RIGG. *Tangent Lines:* PROFESSOR FLORIAN CAJORI 686

Scientific Books:

Hicks on the Analysis of Spectra: DR. CHARLES E. ST. JOHN 687

American Eosins: DR. H. J. CONN 689

Zoological Nomenclature: DR. CHARLES WARDELL STILES 690

Special Articles:

The Organization of the Nervous Mechanism of Respiration: PROFESSOR F. H. PIKE and HELEN C. COOMBS 691

The American Chemical Society: DR. CHARLES L. PARSONS 693

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THE TREND OF AVIAN POPULATIONS IN CALIFORNIA

THERE is one besetting temptation to which any student fairly advanced in the exploration of his chosen field would seem justified in yielding. This temptation is to hold up to close scrutiny any striking generalization given wide publicity, save it be from the most authoritative source—to see whether it be really founded in fact. A case in point has to do with avian populations.

It has been stated or at least implied with increasing frequency in late years, in various publications, especially in those emanating from organizations concerned with bird protection, that serious decrease is taking place in our bird life, and that this decrease is due to the thoughtlessness or perfidy of man and is preventable. These statements and implications are being expressed not only with regard to the longer and more thickly settled eastern United States, but with regard to the west in general, and to California. Confessedly with some *a priori* doubt, but with a view to testing fairly the truth of these dicta, I have undertaken an inquiry into the situation in our own state, for the purpose of finding out what the facts are—of ascertaining whatever changes in our bird population may, indeed, have become apparent, and the causes therefor.

To begin with, of course, terms must be defined. In using the word "decrease," or its opposite, "increase," in this connection, one of two distinct ideas may be in a person's mind. He may refer to the *number of species,* or he may refer to the aggregate *number of individuals.* Or, both of these ideas may be held, in more or less vague association.

To take up the first concept: There is no question whatsoever that a certain few species of birds have become nearly, or quite, extinct, as far as California is concerned, within the

past seventy-five years; as examples, the trumpeter swan and the whooping crane. But, compensating for these losses, there have become newly established within our territory during that same period some species of foreign source; as examples, ring-necked pheasant and English sparrow. Checking up the species of both categories, we can reach but the one conclusion that, as yet, so far as concerns the state as a whole, there has been no real reduction in the total number of species; our known avifauna at the present moment totals 582 species and subspecies; I am aware of no good ground for supposing that it was one unit more or less, seventy-five years ago.

If, however, we narrow our attention to given restricted localities, we are confronted with evidence of real and great reduction in species, up to even forty per cent. of the original number, I figure, in some places. It is this *local* reduction in species, most apparent naturally in centers of human population, that has impressed so strongly the ardent advocates of the various sorts of bird protective measures.

An entirely different phenomenon, as already intimated, is comprised in the fluctuation of aggregate populations, irrespective of the various species, few or many, represented in them. On this point, my impressions are strong that, throughout the country at large, wherever human influence has had any marked effect, there has been *increase* in the bird life. In some localities, as pointed out below, this increase may reach as much as tenfold.

My reader will at once demand something more tangible than "impressions." And I am compelled regretfully to admit that actual figures seem to be wanting. We have no record of censuses taken fifty years ago, or even twenty-five years ago. This is unfortunate; and it is to be hoped that further lapse of time will see an improvement in this situation. Numerical censuses, on either an areal basis or a unit-of-time basis, are now being taken and recorded. The student of the future, let us hope, will have plenty of statistical data upon which to base final conclusions.

It seems, then, that, in this discussion, I must fall back upon less tangible classes of evidence—upon memory and upon inferences from other categories of facts. Before citing this evidence, however, let me introduce some theoretical considerations.

It is a recognized, established principle that the presence in a region of any given bird species is absolutely dependent upon, first, proper food supply, second, the right kind of breeding places, and third, appropriate cover or protection for individuals—each of these conditions as bound up with the inherent structural features of the bird under consideration. Mark that there are *three* of these factors, each and all of them essential; if any one of them in a given region becomes effaced, the bird in question can no longer exist there. There are, of course, other factors essential to avian existence, but they affect all the birds of a given fauna alike. We can deplore, wring our hands, and suffer agonies of regret, but to no avail—except as active steps be taken to restore the critical condition. As a matter of cold circumstance, a bird's disappearance in a given locality may be irretrievable—as happens where man has densely settled a territory and incidentally or purposely destroyed certain of its natural features unnecessary or inimical to his own existence there. Chop down all the trees and there can be no more woodpeckers; drain the lakes, ponds and swamps and there can be no more water birds; remove the chaparral, and wren-tits, bush-tits and thrashers can no longer find proper food and shelter. Cement up all the holes in the campus oaks and there will be no more plain titmouses—for the reason that roosting and brooding places essential to their existence are no longer to be found.

Each bird species native in a given region has a different and very special combination of requirements. Existence of each is really determined by a very slender thread of circumstances which can, in most species, be broken readily. Differences must, of course, be recognized in the degree of hardihood, or of viability, in the various species of birds—some are on the ragged edge of extinction, this condition in part due to inherent reduction in specific vigor—the race is naturally playing out, we say; others are hardy, with a large reserve

of specific energy; some can even stand what may aptly be called ecologic punishment.

In any one locality the field observer comes to recognize a few or many rather intangible units which he calls "ecological niches"—separate cubby-holes or dwelling places or habitats (in the narrowest sense), which differ in essential respects from one another. If the topography and vegetation be varied, there are many of these niches; if more uniform, there are few of them. Each niche is separately occupied by a particular kind of bird, and the locality supports just as many species of birds as there are niches; furthermore, the numbers of individuals of each bird are correlated directly with the degree of prevalence or dominance of the niche to which that particular bird is adapted. In other words,—and here is the crux of the idea,—both the number of the species and the number of the individuals of each species, in a locality, are directly dependent upon the resources of the environment, from an avian standpoint. The same notion holds, of course, for all other animals, including *Homo*.

Rate of reproduction in any species has been established down through past time so as to supply the population needed to keep the appropriate niche filled. This rate varies with the natural prevalence of the niche, and with the hazards to which the niche occupant is exposed. Not only that, but a wide margin above the normal need is provided to meet that extreme emergency which may arise but once in a thousand generations; in other words, there is produced a large surplus—an apparent great waste—of individuals over and above what is needed to keep the appropriate territory fully populated, in order to save the species from extinction at some critical moment; for animate nature abhors a vacuum no less than does inanimate nature. A recent writer in SCIENCE (LV, May 12, 1922, pp. 497-505), Professor A. F. Shull, has, in another connection, called this fact of over-production the "factor of safety." He says: "The entire struggle for existence is based on the principle that security and advancement are best assured through wasteful over-production." The employment of the factor of safety, I would say, is a manifest device on the part of nature to insure continuity of species, and hence also to make evolution possible.

A British ornithologist, Mr. H. E. Howard, has lately put out a book in which he elaborates exhaustively the idea of the importance of territory to bird life. Kind and availability of territory determine the kind and amount of bird life. In final analysis, when a territory, or, as I would express it, more explicitly, an ecological niche, becomes *full*, and this in normal times comes to pass very quickly, the individuals within the species constitute each other's worst enemies. Continued conflict for space—for a piece of land, for an area of meadow, for a section of tree-trunk, for a given unit of volume of twiggery or foliage—is plain to be seen by any diligent observer of bird life. The resulting pressure for territorial expansion reminds one of the same pressure obtaining among humans; only, among birds, there is no organized warfare. The process is one of struggle as between individuals or pairs of individuals, between neighbors, indirectly, perhaps, as a rule; but also, often, directly, by personal action. The most fit to compete, sometimes the most fortunate, will survive; the less fit will be eliminated. The survival prospects of each single individual are small. Vast numbers of individuals are poured in. The "safety factor" in numbers is there in order to insure the persistence, and continued adaptive improvement, *of the species*.

Let us now return to more matter-of-fact considerations. What have been some of the effects of the settlement of California by the white man, upon the environments of birds? Have any ecological niches been effaced? Have any niches been added? Have some been reduced in prevalence and others increased in prevalence, relatively? What have been the effects upon the niche-occupants?

Perhaps the most conspicuous changes wrought in the appearance of the landscape in the southwest have resulted from irrigation. In substantiation of this statement, many of my readers can doubtless appeal to his own memory. I, myself, recall traversing long

stretches of the San Joaquin Valley twenty-five years ago, which were then merely arid plains. The vegetation consisted of xerophilous grasses and herbs, with here and there tracts of lupine or atriplex bushes. The birds observed were scattering horned larks, fewer meadowlarks, and occasional burrowing owls; it being winter, there were more numerous Savannah sparrows and, in rain-dampened places, pipits. Knowing what I do now about censuses, I doubt if there were then more than one bird to the acre, on an average, probably much less than that ratio.

Now, regarding the same territory, it would be hard to exaggerate the amount of change in vegetation which has resulted from the watering of the ground. Orchards, alfalfa fields, green pastures and streams of running water lined with willows, completely occupy the land. Instead of a very uniform type of environment, with only a few niches and correspondingly few species of birds, one finds, upon analysis, a great variety of niches and a much increased number of bird species. What is more, the numbers of *individuals* are vastly larger. To be sure, the horned larks and burrowing owls are gone. But the meadowlarks have multiplied; and, in addition, one sees great numbers of Brewer blackbirds, of mockingbirds, goldfinches, swallows, phœbes and killdeers. I esitmate the mean population over large areas of the San Joaquin in April, when the lowest ebb for the year is reached, at 10 per acre, or over 6,000 per square mile. Here, obviously, the conditions for abundant avian population have been markedly improved by the coming of the white man with his methods of cultivation.

Even more spectacular has been the faunal change wrought by irrigation in Imperial Valley, where luxuriant vegetation with resulting abundance of bird life has replaced the original sparse vegetation of the desert which supported relatively little animal life.

Another biotic modification is brought about by deforestation. Close stands of coniferous trees are replaced by "slashes," by open young growths, or by mixed brush land and trees. Dense forests, it is well known, are sadly lacking in bird population. The removal of the forests has meant, of course, the disappearance of a few, specialized avian tenants. But in their place, occupying the clearings and mixed growths, is a much greater population both as to individuals and species. Kinglets, pileated woodpeckers, and hermit thrushes may have disappeared; but fox sparrows, chipping sparrows, spotted towhees and a host of other birds of like habitat preferences have come in. Certain little niches have been done away with; but the change in the nature of the territory at the hand of the lumberman has resulted in there being many more, new niches; each of these, evidently, of greater amplitude, of greater supporting power.

Very definite change in the other direction has been that made as a result of the draining of swamp lands. Many species thereby have been eliminated, locally, many more species than occupy the reclaimed land; and, furthermore, I feel sure that the numbers of individuals, too, have been reduced, though not in so large proportion. As instances, I would refer to Nigger Slough and Gospel Swamp in southern California, and to the region at the confluence of the Sacramento and San Joaquin Rivers in west-central California. A swamp is really a very complicated type of environment; within it usually may be recognized *many* "niches" and a correspondingly large number of avian occupants. Among these are the herons, rails, gallinules, song sparrows, yellowthroats and tule wrens, and, if there be open water, coots, terns and several species of ducks.

The most serious adverse effect of the human occupancy of California upon bird-life thus far has, I believe, resulted from this reclamation of the swamp lands. But, if you will resort to memory, or examine a topographic map, you will observe that the total area here involved is very small compared with the territory that has been affected oppositely, by irrigation. Irrigated territory, moreover, is subject to continual and much farther spread, while the possibilities of drainage are almost exhausted.

Other modifications of primitive conditions as a result of the white man's occupation of

the country are as follows: By the clearing of brushlands, for example, in San Fernando Valley, Los Angeles County; by the planting of trees, afforestation, as exemplified in the groves of trees around the Greek Theater and on the Berkeley hills; by the cultivation of dry grasslands, as on the coastal benches of San Diego County; and by the formation of storage reservoirs and canals, which, irrespective of the lands which they water, bring into existence aquatic and riparian types of vegetation conducive to an abundant bird life. Some of these it will be noted, check against one another, so that *status quo,* in part of the country, tends in some measure to be maintained.

In general, then, my contention is that there has been, on the average, as a result of the settlement of California, a marked increase in our bird population. Bird life at large has benefited—and this in spite of various adverse features which also have been imposed. My message should be, therefore, one of optimism to the bird-lover. It is to be understood that I refer to birds of all groups together; not to any particular group. There are vastly more of the so-called "song birds," numerically, than there are of the "game birds" and "birds-of-prey." The latter two groups have been seriously depleted, unquestionably, from various causes associated with man; but probably not more than ten per cent. of our original bird population consisted of game birds and birds-of-prey combined.

Permit me now to link up with current notions and beliefs in regard to the status of bird life some of the ideas that I have been endeavoring to express. In a large proportion of cases the reduction or disappearance of a cherished species of bird, locally, such as may have been laid to other entirely different causes, has really been due simply and inevitably to the reduction or complete effacement of the kind of habitat the bird must have for its existence; in other words, its ecologic niche has been reduced in volume, or destroyed. No one could help it; nor can any one now stay the process, except by restituting the lost factor; for example, when land is bought or otherwise preserved from human use and devoted to the use of the birds, as in national or state bird or game reserves. Of course, in certain areas, such as national parks and forest reserves, the environments and the birds occupying them are being preserved anyway, incidental to other interests.

The tendency among sentimentalists has usually been to seek out a cause for the disappearance of birds that is directly concerned with their fellow men. The hunter, the boy with the sling shot, the collector, any one of them or all, loom up as *the* "exterminators of birds"; whereas, in truth, I believe, it is only in rare cases and then only very locally, that *these* agencies have had any effect at all. In other words, if my line of reasoning has been correct, legal protection, with ninety per cent. of our bird species, is absolutely unnecessary, save as it applies, and then properly so, to parks, the suburbs of cities, and to logically constituted game and wild-life preserves, where shooting for *any* purpose is out of order.

Recall the geometrical ratio of reproduction, and the consequent powerful potentiality for recovery on the part of bird species. Let me cite here the case of the eastern bluebird as reviewed by Mr. P. A. Taverner in a recent number of the *Canadian Field-Naturalist* (XXXVI, April, 1922, pp. 71-72). In the winter of 1895-96 a cold wave swept the South Atlantic states, the sole wintering ground of the eastern bluebird. As a result, famine and death reduced the total bluebird population almost, but not quite, to the vanishing point. But in five years the species had recovered "from almost nothing to practical normality." After reaching normal, a "saturation point of population" for the species, it ceased to increase; or, as I would express it, its ecologic niche, of fixed amplitude, was then full. The operation of the "factor of safety" not only saved, but very quickly brought back, the species.

Another catastrophe, recorded by Dr. T. S. Roberts (*Auk,* XXIV, 1907, pp. 369-377) happened to a sparrow-like species, the Lapland longspur, in southwestern Minnesota, the middle of March, 1904. It was migration time,

and a peculiarly wet and thick snowstorm that occurred during the night of the thirteenth is thought to have overwhelmed the birds when in flight high overhead, soaking their plumage and dazing them. At any rate, great numbers hit the ground with fatal violence. In the morning dead and injured birds were to be seen over a wide stretch of country; on the frozen surfaces of two lakes 750,000 dead longspurs were counted, by the method of laying off sample units of area and checking the birds to be seen on these units. But in spite of this spectacular destruction of individuals the Lapland longspur was not reported the following years in the winter range of the species (Kansas, etc.) as obviously less numerous than usual. Did not the ability of the species to recover from this extraordinary calamity rest in the "factor of safety"?

There is good reason to believe that release of intra-specific pressure on the breeding grounds of a species is accompanied by greater productivity on the part of the remaining population. The survival chances for the young are greater where the safest type of nesting places is available to all the adults seeking to breed, and where congestion of population, and consequent drain on available food supply, has been relieved. Also, towards the end of the year, when the annual pinch of food scarcity comes into play, in the winter range, a larger proportion of maturing individuals than usual will survive. In other words, from one point of view, calamitous reduction of population benefits the immediately oncoming generations.

Let me center attention now upon the significant fact that certain of our birds are, and always have been, totally *un*protected by either law or sentiment—jays, crows, linnets, shrikes and blackbirds. The rate of annual increase in those species is no different, in so far as I am aware, than it is in the vireos, warblers, mockingbirds, tanagers, and purple finches, which latter are looked upon as desirable songbirds. Yet the former are holding their own just as well as the latter, protected, species. Their numbers are always kept up to top-notch commensurately with the prevalence of their niches. They have reached the maximum population possible to them, consistent with the nature of the country, and they hold to it.

We all know of the enmity of orchardists, and agriculturists, and sportsmen toward linnets, blackbirds and blue jays, respectively. Now and then, and there is a case on record as far back as thirty years ago, "blue jay hunts" are held; in one lately recorded instance, at Hollister, San Benito County, 1,531 California jays were killed in one day, in a prize competition for the destruction of so-called "vermin." Incidentally, you will note that sportsmen feel particular animosity toward any competitor or rival in their own field! They are right after anything that can be called "vermin" from their standpoint. As far as we can see, as a result of such campaigns—shooting of blue jays, netting of blackbirds, and poisoning of linnets—there has been only a very temporary and local reduction in the numbers of these birds; two or three seasons bring them back to normal: that is, to the maximum numbers which the amplitude of their respective niches will warrant.

Bird population, in kind and quantity, is controlled primarily by conditions of habitat. It is a matter of food and shelter. The natural history collector, as a factor against birds, is only an exceedingly minor influence, one which like all the others, is allowed for by the "factor of safety." My readers will begin to suspect that I have become sensitive because of the inveighing that certain well-meaning but uninformed people have undertaken against the killing of birds for specimens. I admit the score.

JOSEPH GRINNELL

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ARE PERMANENT DISTURBANCES OF EQUILIBRATION INHERITED?

THE writer of this note has just brought to completion a long series of studies upon the mechanics of equilibration in the white rat. During the course of these studies certain facts appeared which, though incidental to the original problem, may be of importance in the

field of genetics. The facts were observed under the following conditions. As a part of our method, we found it necessary to rotate white rats day and night in small revolving cages over a period of several months. The cylindrical cages, less than a foot in diameter, were rotated in a horizontal plane, some at sixty and others at ninety times a minute. Several months after this series of continuous rotations began, a part of the subjects were removed from the rotating cylinder (a) in order to make observations on their behavior subsequent to their long continued rotation, and (b) in order to make room for litters which were born from time to time within the cylinders. Several weeks (the time has varied from individual to individual) after these first subjects had been removed from the rotating cylinders, it was discovered that permanent changes in bodily movement and posture had taken place. The most striking changes were (a) circular movements about the nest, usually in the direction of the long continued rotation, and (b) a decided turning or twisting of the head to the right or to the left. It was discovered, moreover, that these changes in posture were occasionally accompanied by swellings and discharges from the region of the ear, and more frequently, by decreasing bodily tonicity and finally by death. Further search revealed the fact that this state of "disequilibration" was accompanied by important changes in the character and in the duration of the ocular movements following short rotation periods (20 turns in 10 seconds).

Before the appearance of this state of "disequilibration," a few of the subjects with a long history of rotation were mated with other rotated and unrotated individuals solely for the purpose of adding to our experimental stock. Curiously enough, however, individuals began to appear in successive generations presenting the same types of disequilibration observed in the parents. That is to say, rotated individuals mated weeks after having been taken from the revolving nests gave offspring a part of which were disequilibrated in the same manner as their parents. Subjects of this kind have continued to appear at various intervals during the past two years. They have even been discovered in the third generation after rotation. Up to this time about sixty disequilibrated individuals have been counted in a total population of approximately five hundred.

Unfortunately, the demands of the experiments upon equilibration made it impossible to investigate adequately the genetic implications involved in these materials. Nevertheless, the facts as such were considered striking enough to warrant their presentation at a meeting of the Society of American Naturalists in 1921. The questions and suggestions received at that time have led to the conclusion that the biological aspects of the problem should be established and that definite attempts should be made to discover (a) whether the stock in our laboratory may not have given one or more mutations or segregates which, in turn, became the progenitors of the curious individuals still apparent; (b) whether an experimental method of modifying the function of an important organ has been accidentally discovered; and (c) whether actual inheritance of such an acquired bodily change can be demonstrated. The first suggestion seems improbable because no similar rats have appeared in a large related control stock running along with the experimental stock. Furthermore, the character of the disequilibration has appeared to be regularly dependent upon the direction in which the ancestors were rotated. With respect to the third problem, namely, a possible demonstration of the inheritance of acquired vestibular changes, a number of biologists have offered the suggestion that long continued rotation may have induced the production of toxins or of other substances which, in turn, operate after the fashion of the lens anti-bodies, recently described by Guyer and Smith.

It seems desirable, then, to institute a new series of rotations with a new stock and to use, as well, other means of inducing disturbances in the semicircular canals so that more reliable evidence for or against the apparent cases of inheritance in our own stock may be discovered. It is also desirable to know what morphological and structural changes have taken place in the vestibular areas subsequent to long-continued

excitation. Fortunately, Professor J. A. Detlefsen, who has cooperated with the writer ever since the first cases of disequilibration appeared, is able to devote a sabbatical year at the Wistar Institute to the further investigation of the facts above described.

C. R. GRIFFITH

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THE USEFULNESS OF ANALYTIC ABSTRACTS

THE various ways in which preliminary abstracts should be of service to scientific readers were pointed out about a year ago[1], but whether such abstracts as actually prepared and published would be worth while could be determined only by experiment. This has been done. After analytic abstracts had been appearing in the *Astrophysical Journal* and the *Physical Review*[2] for over two years the following return post-card questionnaire was sent by the chairman of the Division of Physical Sciences of the National Research Council to each reader, with the request that he underscore in each parenthesis the word or words which represent his answer to the question implied:

I look through (the *Astrophysical Journal*, the *Physical Review*) regularly. Before reading the articles, I read the abstracts (always, usually, sometimes, seldom, never). Instead of reading the articles, I read the abstracts in (many, some, few, no) cases. The abstracts have helped me understand the articles in (some, few, no) cases. The abstracts have proved useful in locating information in (some, few, no) cases. I read the subtitles in the abstracts first (sometimes, never). I find the subtitles of value as an index of the abstract (sometimes, never). The abstracts in general give (too much, too little, about enough) information. I think they should be continued (yes, no).

I have the following suggestions to make:

1 "Scientific Abstracting" by G. S. Fulcher, SCIENCE 54, 291, September 30, 1921.

2 The preliminary abstracts in the *Physical Review* are called "Synopses" to distinguish them from the abstracts of papers presented at meetings which are printed in connection with the proceedings of the Society.

Replies were received from 805 readers, including 83 readers of the *Astrophysical Journal*, 502 readers of the *Physical Review*, and 220 readers of both. Although the answers from the three groups have been tabulated separately, the results are so nearly the same for each that only the results for all readers, that is, the percentages of all readers answering each question in each alternative way, will be given here. Since some replies are incomplete, the sum of the percentages is usually less than 100.

1. How frequently are the abstracts read before the articles?

always	by	41.9	per cent. of readers.
usually	by	45.9	per cent. of readers.
sometimes	by	9.9	per cent. of readers.
seldom	by	2.1	per cent. of readers.
never	by	0.2	per cent. of readers.
		100.0	per cent.

2. How many abstracts are read instead of the articles?

many	by	44.5	per cent. of readers.
some	by	39.7	per cent. of readers.
few	by	9.5	per cent. of readers.
none	by	2.6	per cent. of readers.
		96.3	per cent.

3. How many abstracts helped in understanding the articles?

some helped	58.1	per cent. of readers.
few helped	17.7	per cent. of readers.
none helped	11.8	per cent. of readers.
	87.6	per cent.

4. How many abstracts have proved useful in locating information?

some useful to	59.3	per cent. of readers.
few useful to	16.6	per cent. of readers.
none useful to	11.4	per cent. of readers.
	87.3	per cent.

5. Should the abstracts be continued?

yes	92.8	per cent. of readers.
no	4.0	per cent. of readers.
	96.8	per cent.

Since the abstracts are read, always or usually, by 88 per cent. of the readers; are read

instead of many of the articles by 45 per cent.; and have been found helpful in other ways by 59 per cent., they have evidently proved of decided value. In what ways? According to the testimony of the readers: "They are great time savers"; "They frequently give all information necessary about the articles"; "They double a man's range of reading." Moreover, the abstracts have been copied verbatim in *Science Abstracts* and have thus reduced the labor of preparing that abstract journal by ten per cent. The abstracts have therefore to some extent fulfilled their purpose of saving the time of scientific men.

How about other sciences? Are astronomy and physics essentially different from chemistry, botany, zoology, geology, physiology, etc., in their methods of disseminating scientific information? If 93 per cent. of the readers of these astronomical and physical journals find that preliminary abstracts are useful to them, would not the great majority of other scientific readers also find such abstracts useful? The responsibility resting upon the editors of other scientific journals is clear.

Now as to the nature of the abstracts which should be provided. The abstracts which have been appearing in the *Astrophysical Journal* and *Physical Review* are of the analytic type developed by the National Research Council.[3] They aim to give a complete description and adequate summary of the results reported in each article. The replies to the question:

6. Is the amount of information given, in general, about enough, too little, or too much?

about enough	79.8 per cent. of readers.
too little	6.7 per cent. of readers.
too much	4.8 per cent. of readers.
	91.3 per cent.

these replies indicate that the abstracts, averaging from 5 to 6 per cent. of the articles, have been of about the right length, and it is not believed they could be made much shorter without considerably decreasing their value.

A distinctive feature of the abstracts is that they contain italicized subtitles which give the various subjects involved more completely and precisely than in general it is possible for the author's titles to do. One purpose of these subtitles is to enable a reader who is not interested in the subject indicated by the author's title to determine by glancing through the subtitles whether something of interest to him has not been incidentally included. Until readers became accustomed to these subtitles, however, it was to be expected that most readers would consider them more of an annoyance than a help; but the following replies show that a surprising percentage of the readers have already found the subtitles useful:

7. Do you ever read the subtitles in the abstracts first?

sometimes	64.1 per cent. of readers.
never	17.5 per cent. of readers.
	81.6 per cent.

8. Do you ever find the subtitles of value as an index of the abstract?

sometimes	63.0 per cent. of readers.
never	12.7 per cent. of readers.
	75.7 per cent.

Since the subtitles also serve the purpose of assisting in the compilation of a complete subject index and tend to insure more complete abstracts, it is believed this feature should be retained. Only three readers definitely objected to the form of the analytic abstracts.

It is the practice of both these journals to submit all authors' abstracts to an abstract editor to be revised or if necessary rewritten, in conformity with the standards adopted. While a few authors have objected to having their abstracts "robbed of individuality," a number of readers specially called attention to the importance of having the abstracts edited so that a uniform standard might be maintained. It can safely be affirmed that since most authors are inexperienced in writing abstracts and also differ widely in their ideas of the function of the abstract, authors' abstracts if not thoroughly edited are sure to fall far short of rendering the service which preliminary abstracts should render, even if detailed instructions are furnished. But after the edited abstracts begin to appear regularly, they

[3] Described in "Scientific Abstracting" referred to above.

gradually establish a standard to which authors will conform more and more closely as time goes on, and therefore the amount of editing required will become less and less.

Finally, mention should be made of the suggestion of several readers that larger type be used for the abstracts than has been the custom. Since more people read the abstracts than read the articles, it would seem obvious that the type of the abstracts should be at least as large as that of the articles.

It should not be long before all scientific journals, in fulfilment of their duty toward their readers, provide carefully prepared preliminary abstracts of their scientific articles. There can no longer be any doubt of the value of such abstracts. It remains only to overcome the practical obstacles to the introduction of the new policy.

In conclusion we desire to express our thanks to the 805 readers whose cooperation gave us the information herewith reported.

GORDON S. FULCHER
CORNING GLASS WORKS

SCIENTIFIC EVENTS

CONSERVATION OF THE RESOURCES OF THE PACIFIC

The following resolutions were unanimously adopted by the Pan-Pacific Union Commercial Conference, meeting at Honolulu on November 7, 1922:

Whereas, It is known that many valuable species of marine mammals such as fur seal, sea otters, elephant seals and whale, and many species of important food fishes such as salmon and halibut, formerly occurred in the Pacific in such vast numbers as to constitute the objects of fisheries whose annual products were worth more than one hundred million dollars, and

Whereas, Nearly all of those great natural resources have been seriously depleted, many of them even to commercial extinction, through greed and short-sightedness and ill-considered fishery methods, and

Whereas, It is known that small remnants of fur-seal and sea-otter herds and small numbers of whales and of other commercially valuable species still remain in certain places, and

Whereas, The rapid recovery of the Alaska fur-seal herd in the short period of ten years from complete commercial ruin to an annual production of more than one million five hundred thousand dollars, as a result of the international fur-seal treaty of 1911, demonstrates conclusively the wonderful recuperative power of such depleted natural resources of the sea under international cooperation, and justifies the belief that other depleted fisheries can be rehabilitated through similar cooperation among the nations concerned, and

Whereas, It is conservatively estimated that these resources when rehabilitated will yield to the world a regular annual product of more than one half billion dollars in value, therefore be it

Resolved, That the Pan-Pacific Commercial Conference strongly recommends that the various countries bordering on, or interested in, the Pacific, take such steps as may be necessary to bring about an international treaty for the restoration of the vanishing resources of the Pacific to their former abundance, that they may be maintained for all time as the objects of great commercial fisheries of which they are easily capable, and be it further

Resolved, That this Commercial Conference recommends that the governments of the countries bordering on the Pacific enter into correspondence for the purpose of establishing an international commission for the scientific study of the biology, physics and chemistry of the Pacific in the interest of the restoration, proper utilization and conservation of its vanishing natural resources.

THE UNIVERSITY OF WYOMING AND DR. NELSON

THE trustees of the University of Wyoming have passed the following resolutions:

Whereas, Dr. Aven Nelson, after five years as president of the University of Wyoming, resigned at the June meeting of the board of trustees, and

Whereas, His activities as president ceased October 2, upon the arrival of his successor, Dr. Arthur G. Crane, of Edinboro, Pennsylvania, and

Whereas, Dr. Nelson has served this university in various capacities from the infancy of the institution, in all of which he has succeeded to a high degree, and

Whereas, His industry, his patience and his scholarship were controlling factors in carrying the University of Wyoming through the world war and the reconstruction period thereafter to its present success.

Be it resolved, By the board of trustees of the University of Wyoming that we appreciate more fully than we can express his splendid loyalty and labors; that we extend to him our sincere wishes for a continued pleasant relationship upon his return to his former position as professor of botany; that we bespeak for him and Mrs. Nelson a long and happy life and all the joy and satisfaction which come from real service and the knowledge of a duty well done.

Resolved, That this expression of our good will be made a part of the permanent records of this board, and a copy thereof be transmitted to Dr. Nelson.

W. C. DEMING,
President, the Board of Trustees

THE INDUSTRIAL DIVISION OF THE AMERICAN CHEMICAL SOCIETY

IN order that more time can be given to the presentation and discussion of papers delivered before the Industrial Division, American Chemical Society, it has been decided to ask all who plan to give papers before this division to submit completed manuscripts not later than March first to the secretary of the division. The manuscripts will then be sent to reviewers in a similar manner as contributed articles now submitted to any of the journals of the American Chemical Society. Upon favorable recommendation of the reviewers and the officers of the division, the papers will be included in the final program of the division.

It has been keenly felt for some time that something must be done to raise the standard of some of the papers which have been given before the division. No doubt the new method will reduce the number of papers to be presented at any one meeting, but it is felt that a few genuinely good papers followed by a sufficient time for discussion will be what most chemists desire. At Pittsburgh there were so many papers on the program that a time limit of seven minutes was allotted with three minutes for discussion. This time proved to be so short that a speaker could not present the paper in the best manner possible, and the period for discussion was so short that there was practically no attempt on the part of members to discuss the subject.

Since the spring meeting occurs at New Haven from April 3 to 7, inclusive, it is necessary for members of the American Chemical Society who are planning to present papers before the industrial division to send their papers on or before March 1 to the secretary of the division.

ERLE M. BILLINGS,
Secretary
INDUSTRIAL DIVISION,
AMERICAN CHEMICAL SOCIETY,
KODAK PARK, ROCHESTER, N. Y.

THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

THE most important business before many of the societies concerned at the Christmas meetings is the consideration of the proposed organization of the Union of American Biological Societies.[1]

That there is strength in union has long been believed. The practical questions before the biologists of the country are two: first, is it possible to achieve effective union in the diversity of biological interests; second, is the proposed Union of American Biological Societies a sufficiently well thought out plan of organization to give fair promise of effectiveness?

The answer to the first question would seem to be a clear and obvious "Yes." More diverse groups have already shown that they can by union achieve cohesiveness and power. The unbroken record of history, from the time when Benjamin Franklin said, "We must hang together or we will hang separately," to the present, from the first pooling of the common interests of unlike individuals to the Standard Oil Company and the American Chemical Society gives testimony to the real effectiveness and power of united effort.

As to the second question, that can only be answered after a study of the plan of organiza-

[1] The original name was the Federation of American Biologial Societies. The word *Federation* in the Constitution has been changed by vote of the temporary executive committee to *Union* because of the confusion that some have thought would be caused by the similarity of the first provisional name to that of a small group of societies already organized.

tion as published in SCIENCE of September 29. The plan has evolved after long discussion as a matured expression of opinion of the representatives of some twenty-five organized groups of biologists. If this plan fails it seems likely that we will wait a very long time for any improvement to come to biology from the concerted efforts of its scattered votaries.

I. F. LEWIS,
Chairman Temporary Executive Committee

HOTELS FOR THE BOSTON MEETING

THE local committee for the Boston meeting has supplied the permanent secretary's office with a list of the Boston hotels and their rates, which is given below. The hotels are conveniently considered in five groups, according to their locations. The following grouping is employed in the tabular arrangement:

Group 1, north end of Boston Common: Bellevue Parker House, Quincy House, Young's.

Group 2, south end of Boston Common: Adams House, Touraine, Avery.

Group 3, Copley Square and vicinity: Copley Square, Copley Plaza, Garrison Hall, Brunswick, Vendome, Victoria, Westminster, Lenox.

Group 4, Upper Back Bay: Buckminster, Puritan, Somerset.

Group 5, other hotels, each within a ten-minute walk of one of the above groups (They furnish excellent accommodations for those not requiring a headquarters hotel): Essex (opposite South Station), Arlington, Savoy (Columbus Avenue, near West Newton Street), United States (Beach Street, near South Station).

BOSTON HOTELS

NAME OF HOTEL	GROUP NO.	RATES			
		WITHOUT BATH		WITH BATH	
		SINGLE	DOUBLE	SINGLE	DOUBLE
Adams House	2	$2.00-$2.50-$3.00	$3.50-$4.00-$5.00	$4.00-$4.50-$5.00	$6.00 and up
Copley Square	3	$2.50	$3.50	$3.50	$5.00-$6.00 up
Copley Plaza	3	.....	.....	$4.50-$6.00 up	$8.00 and up
Garrison Hall	3	$2.50 and up. Several suites for 2 to 6 persons.			
Arlington	5	.....	.....	$2.50-$3.00-$3.50	$3.50-$4.00
Bellevue	1	$3.00 and up	$4.00-$5.00	$4.00-$5.00	$6.00-$10.00
Brunswick	3	$2.50-$3.50	$4.50-$6.00	$4.00-$5.00	$6.00-$7.00
Buckminster	4	Residence hotel—Limited accommodations—singly and en suite.			
Essex	5	$2.00-$2.50	.....	$3.00-$4.00	$6.00-$7.00
Puritan	4	.....	.....	$5.00-$7.00	$6 00-$8.00
Savoy	5	.....	.....	$2.00-$2.50-$3.00	$2.50-$3.00-$4.00
Somerset	4	$4.00	$5.00	$5.00-$6.00-$7.00	$6.00-$7.00-$8.00
Touraine	2	$3.00-$4.00-$5.00	$5.50-$7.00	$5.00-$7.00	$7.50-$10.00
Vendome	3	$7.00-$13.00—American plan.			
Victoria	3	$3.00	$5.00	$4.00	$6.00
Westminster	3	$2.50	$5.00	$3.50	$6.00-$7.00
Parker House	1	$2.50-$3.50	$4.00-$5.00	$3.50-$5.00	$5.50-$8.00
Quincy House	1	$2.00-$2.50	.....	$3.00 and up	.....
Young's Hotel	1	.....	.....	$4.50 and up	$5.50 and up
United Staes	5	$2.50	$4.00	$3.50-$4.00	$4.50-$5.50
Avery	2	.....	.....	.....	$5.00-$6.00
Lenox	3	$3.00-$3.50	$4.00-$5.00	$3.50-$6.00	$5.00-$8.00

SCIENTIFIC NOTES AND NEWS

BIOGRAPHIES of members of the National Academy of Sciences who died during the year 1922 will be prepared as follows: A. Graham Bell, by Dr. John J. Carty; J. C. Branner, by Professor Bailey Willis; Wm. S. Halsted, by Dr. Wm. H. Welch; Henry M. Howe, by Dr. Edwin H. Hall; Alfred G. Mayor, by Dr. Charles B. Davenport; Alexander Smith, by Professor W. A. Noyes.

To Dr. Fridtjof Nansen, the Norwegian Arctic explorer and zoologist, has been awarded the Nobel Peace Prize for his work in relieving the starving populations of Russia and Asia Minor and for his endeavors to promote the brotherhood of nations.

AT the anniversary meeting of the Royal Society on November 30, the following members of the council were elected: *President,* Sir Charles Sherrington; *treasurer,* Sir David Prain; *secretaries,* Mr. W. B. Hardy and Dr.

J. H. Jeans; *foreign secretary,* Sir Arthur Schuster; *other members,* Professor V. H. Blackman, Professor H. C. H. Carpenter, Professor T. R. Elliott, Professor A. Harden, Sir Sidney Harmer, Professor W. M. Hicks, Professor H. F. Newall, Professor G. H. F. Nuttall, Professor D. Noel Paton, Lord Rayleigh, Professor O. W. Richardson, Sir Ernest Rutherford, Dr. Alexander Scott, Mr. F. E. Smith, Sir Aubrey Strahan and Professor J. T. Wilson.

DR. WALTER B. CANNON, professor of physiology in the Harvard Medical School, colonel of the Medical Officers' Reserve Corps, has been awarded a distinguished service medal citation by the War Department. The citation reads: "For exceptionally meritorious and distinguished services as director of physiological research for the American Expeditionary Forces in France. His activities in connection with the development of a standard method for the resuscitation of the wounded and in organizing, instructing and directing the work of shock teams in hospitals at the front reflected professional skill and judgment of the highest order, and resulted in saving many lives."

ERNST G. FISHER, chief mechanical engineer in the U. S. Coast and Geodetic Survey, has retired from the service, after over thirty-five years of active work for the government.

MISS ELEANOR PHILBROOK CUSHING has been appointed professor emeritus of mathematics of Smith College.

JOSEPH W. GRIEG, recently assistant in the department of mineralogy at Columbia University, has been added to the staff of the Geophysical Laboratory, Carnegie Institution of Washington, as a petrologist.

DR. J. S. JOFFE has been appointed associate in research (bacteriology) in the New York State Agricultural Station, beginning January 1, 1923, *vice* G. J. Hucker, who has been granted leave of absence for the academic year 1922-23.

THE official canvass of the vote in New York State shows that Dr. Charles P. Steinmetz, of the General Electric Company, who was a candidate for state engineer on the socialist and labor tickets, received 291,763 votes.

DR. JAN SRÁNEK has been appointed minister of health of Czechoslovakia, to succeed Dr. Bohumil Vrbensky.

DR. RUPERT BLUE, former surgeon-general of the U. S. Public Health Service, is attending the Near East Conference at Lausanne, Switzerland, as technical adviser to the American observers on the question of the control of maritime quarantine in the Near East.

C. P. LOUNSBURY, entomologist of the Union of South Africa, who has been in official entomological work for twenty-six years at Cape Town, is visiting the United States.

DR. LOUIS CANTOR, chief sanitary officer to the British administration in Palestine, is in the United States, studying sanitation methods in the larger cities for use in Palestine. He states that modern sanitary systems are rapidly eliminating malaria and trachoma in that country.

DR. W. J. HUMPHREYS, meteorological physicist of the U. S. Weather Bureau, lectured on "Fogs and clouds" to the Pittsfield, Mass., section of the American Institute of Electrical Engineers on November 9. During the following week he gave four lectures on the properties and movements of the atmosphere to the aviation officers at Langley Field, and on December 13 he spoke on "Fogs and clouds" to the department of physics of the Brooklyn Institute of Arts and Sciences.

DR. C. E. KENNETH MEES, director of the research laboratories of the Eastman Kodak Company, lectured before the Franklin Institute of Philadelphia on December 7 on "Recent advances in photographic theory."

PROFESSOR VICTOR LENHER, of the University of Wisconsin, addressed the state branch of the American Chemical Society during the last week of November on the subject of "Selenium oxychloride," the new solvent which he has discovered.

A SERIES of lectures by John Dewey will be

delivered in part (and later published complete) in Union Theological Seminary before the coming joint meeting of the eastern and western divisions of the American Philosophical Association on December 27, 28 and 29. Under the general caption of "Experience and Philosophy," but subject to alteration, Professor Dewey proposes the following tentative outline: (1) Experience and philosophical method; (2) Experience and reason; (3) Experience and selves; (4) Experience and the psychical; (5) Experience and values; (6) Experience and metaphysics.

DR. EDGAR F. SMITH, former provost of the university and president of the American Chemical Society, gave a lecture recently, in the Harrison Laboratory of the University of Pennsylvania, on Joseph Priestley. The lecture was under the auspices of the Priestley Club. Dr. Smith, author of a biography of Priestley, showed for the first time many exhibits of Priestley and his work.

SIR CHARLES A. PARSONS delivered the second Joule memorial lecture at the Manchester Literary and Philosophical Society's house on Tuesday, December 5, his subject being "The rise of motive power and the work of Joule."

THE Henry Sidgwick memorial lecture at Newnham College, Cambridge, was delivered by Lord Rayleigh on December 2, the subject being "The iridescent colors of natural objects."

DR. VICTOR C. VAUGHAN, of the School of Medicine of the University of Michigan, gave a public address on December 6 under the auspices of the chapter of Sigma Xi of the University of Wisconsin, in commemoration of the hundredth anniversary of the birth of Pasteur.

AT the ceremonies to be held, December 26, under the auspices of the Academy of Medicine to commemorate the centenary of Pasteur, papers dealing with the development of Pasteur's work in the various branches of medical science will be read by Delezenne, for general biology; Widal, for medicine; Delbet, for surgery; Wallich, for obstetrics; Barrier, for veterinary medicine, and Calmette, for hygiene.

CHARLES FRANKLIN EMERSON, dean emeritus of Dartmouth College, and formerly professor of astronomy and physics, who was at the college from 1865, when he entered, until 1913, when he retired as dean at the age of seventy years, died on December 1.

CHARLES ALBERT FISCHER, professor of mathematics and astronomy at Trinity College, died at the Hartford Hospital, following an operation for appendicitis on December 9, aged forty-eight years.

DR. EMIL HOLMGREN, professor of histology at Stockholm, has died at the age of fifty-six years.

DR. JOHANNES PETRUS KUENEN, professor of physics in the University of Leyden, died on September 25, aged fifty-eight years.

THE death is announced of M. Barbier, correspondent of the Section of Chemistry of the Paris Academy of Sciences, at the age of seventy-five years.

IN honor of the late Lieutenant Colonel E. F. Harrison, who shortly before his death on November 4, 1918, became head of the British Chemical Warfare Department, a fund amounting to £1,640 has been collected. A memorial to Colonel Harrison and other members of the Chemical Society of London who lost their lives during the war has been erected, and a prize has been established for the chemist under thirty years of age who has carried out the most meritorious researches in chemistry.

THE executive committee of the Australian National Research Council has fixed the date of the Second Pan-Pacific Scientific Congress as August 13 to September 3, 1923. It is proposed to hold the first session at the University of Melbourne, and the second session (August 21 to September 3, at the University of Sydney. From Melbourne and Sydney as centers, excursions are planned as part of the congress program and, after the adjournment of the formal meeting, opportunities will be provided for visits to more remote parts of the continent.

THE tenth annual meeting of the Indian Science Congress, under the auspices of the

Asiatic Society of Bengal, will be held at Lucknow on January 8 to 13, 1923. The congress will be opened by Sir Spencer Harcourt Butler, governor of the United Provinces, who has consented to be patron. The president of the congress is Sir M. Visesvaraya, and the presidents of the sections are as follows: *Agriculture:* Dr. Kunjan Pillai, Trivandrum; *physics:* Dr. S. K. Banerji, director of the Observatory, Colaba, Bombay; *chemistry:* Dr. A. N. Meldrum, Royal Institute, Bombay; *botany:* Mrs. Howard, Pusa; *zoology:* Professor G. Matthai, Government College, Lahore; *geology:* Dr. Pascoe, Indian Museum, Calcutta; *medical research:* Lieutenant Colonel Sprawson, Lucknow; *anthropology:* Dr. J. J. Modi, Bombay. In addition to the regular program of the meetings of the scientific sections, a series of general scientific discussions has been organized, beginning with one on colloids by Dr. S. S. Bhatnagar, of Benares. A series of illustrated public lectures on subjects of popular scientific interest has also been arranged, details of which will be announced later. Further particulars regarding the congress may be obtained from Dr. C. V. Raman, general secretary, Indian Science Congress, 210 Bowbazaar Street, Calcutta.

THE Colorado College science departments have for two years maintained an undergraduate honorary society, Delta Epsilon. The purpose of the organization is to stimulate interest in scientific research and achievement. Members are elected on the basis of promise of research ability. At the first meeting of this academic year R. J. Gilmore, professor of biology, discussed "Hormones and heredity."

UNDER the will of the late Dr. Carl von Ruck, Asheville, N. C., approximately $700,000 has been bequeathed for scientific research work on the prevention and cure of tuberculosis. The von Ruck Research Laboratory will have charge of the fund, and the earnings are to be expended by the corporation for "scientific research, study and experiment in tuberculosis and for the aid of tuberculous patients who are unable to procure adequate and satisfactory treatment."

AT the annual dinner of the London School of Tropical Medicine, held on November 1, it was announced by Sir Arthur Robinson of the ministry of health that a scheme was under consideration whereby the London School of Tropical Medicine would be incorporated with the new Institute of Hygiene, which was made possible by a gift from the Rockefeller Foundation of New York. Sir Havelock Charles said that, if the aspirations of the school were met, the support of the staff and students would be freely given the new arrangements.

THROUGH the president, M. Appell, the Marquise of Arconati-Visconti has given the sum of 100,000 francs to the French National Committee to Aid Scientific Research.

THE Paris correspondent of the *Journal* of the American Medical Association writes that French laboratories "are lacking in financial resources, and that they find it difficult to supply what is indispensable in the way of instruments and to secure the new men needed. This state of affairs, so profoundly regrettable, was clearly brought out at a recent meeting of a group of scientists held under the auspices of the *Bienvenue française,* to which representatives of the lay press had been invited. Two ways are open to remedy the situation. Professor Appell, rector of the University of Paris, has announced that a national committee for the aid of scientific research has been founded. It is also planned to address an appeal to M. Poincaré, president of the council of ministers, to authorize, in connection with the centenary of Pasteur, a *journée nationale* in favor of our laboratories."

IN the course of a field trip the past summer with a class from the University of Chicago, Dr. Adolph C. Noé, assistant professor of paleobotany, secured from Mr. C. D. Young, of Morris, Illinois, a valuable collection of fossil plants and animals from the Mazon Creek. Mr. Young, who is master in chancery of Grundy County, presented the collection to the University of Chicago. It consists of 900 choice specimens selected from a great number which Mr. Young has been collecting through nearly forty years, and is the last great private

collection of Illinois fossils available. The collection, which represents a value of several thousand dollars and was given to the university without any conditions or reservations, will be housed in the Walker Museum of the university.

THE Liquid Carbonic Division of the Compressed Gas Manufacturers' Association announces the establishment of an industrial fellowship in the Mellon Institute of Industrial Research of the University of Pittsburgh, for the purpose of classifying, studying and developing the uses for liquid carbon dioxide. The founding of this fellowship is in accord with the desire of the members of the association to cooperate with users and prospective users of liquid carbon dioxide, with the object of developing efficient means of applying the gas and of obtaining fundamental data bearing on its use in various industries. In addition to conducting research work, the fellowship will be made a clearing-house of information regarding various uses of liquid carbon dioxide, and data will be kept on file for the accommodation of prospective users of this product. The present incumbent of the fellowship is Charles L. Jones, who will be glad to correspond with any one interested in the use of liquid carbon dioxide in industry.

UNIVERSITY AND EDUCATIONAL NOTES

SIR WILLIAM DUNN'S trustees have provided the sum of £100,000 for the establishment of a school of pathology at Oxford. They have also endowed with £10,000 a readership in biochemistry at Cambridge.

THE French government has offered a number of scholarships to Canadian universities, including the universities of Toronto, McGill, Laval and Ottawa. The winner of a scholarship will spend the next academic year in France. The scholarship has a value of 6,000 francs, with an additional 1,000 francs for traveling expenses.

MAJOR GENERAL LEONARD WOOD has resigned the office of provost of the University of Pennsylvania in order to remain as governor general of the Philippine Islands.

DR. STEPHEN S. COLVIN, professor of educational psychology at Brown University, has been elected professor of education at Teachers College, Columbia University. Dr. George A. Coe and Dr. Albert Shiels have also been elected professors of education.

DR. ALBERT SALATHE, of the College of Pharmacy at Albany, has been appointed head of the department of chemistry of Sweet Briar College, and Dr. Frederick William Stacy, formerly of the Florida State College for Women, has been appointed head of the department of psychology.

A COURSE of lectures on "Animal Psychology" will be delivered at Harvard University during the second half of the current college year by Dr. Wallace Craig, formerly professor of philosophy at the University of Maine.

M. AUGER has been appointed director of the laboratory of analytical chemistry at the University of Paris, to succeed the late M. Ouvrard.

PROFESSOR MAX BODENSTEIN has been invited to succeed Professor Nernst as head of the Physical-Chemical Institute of the University of Berlin.

DISCUSSION AND CORRESPONDENCE

GLACIATION IN THE CORDILLERAN REGION[1]

TO THE EDITOR OF SCIENCE: Communications on the above subject by Thomas Large and Frank Leverett have appeared, respectively, in the September 22 and October 6 issues of SCIENCE. To these the writer wishes to add that during May and June, 1922, he found glacial drift including till with striated stones similar to that mentioned by Leverett at many other places on the Columbia Plateau west and southwest of Spokane. The writer expects to study the region further and to publish the results later on, but the information now at hand is sufficient to warrant the statement that

[1] Published by permission of the Director of the U. S. Geological Survey.

during one or more comparatively early stages of the Pleistocene ice from the north advanced over the Columbia Plateau in a southwesterly direction far beyond what heretofore has been regarded as the southern limit of glaciation. The evidence at hand tends to show that the ice extended at least over large parts of Spokane, Lincoln and Adams counties, and less complete information suggests the possibility that the glaciation extended much farther.

Concerning the glacial drift, which by the way is not the only evidence the region affords that land ice was formerly present, the alternative ideas that it was brought to place by floating ice or running water have been considered and rejected. Large patches of the drift may be seen southwest of Cheney, west of Lantz, and in the neighborhoods of Winona, Lacrosse and Kahlotus, these occurrences being selected for mention at random and not because they are more typical than scores of others scattered throughout the region.

The writer wishes to point out that he does not herein attempt to correlate or otherwise define the relations between the glaciation described and the glaciation already known to have covered the plateau west of the Grand Coulee or an ice stream which, as shown by recent observations, traversed the coulee itself.

J. T. PARDEE

U. S. GEOLOGICAL SURVEY

EFFECTS OF COPPER WIRE ON TREES

IN 1918 the writer heard it stated that shade trees were being killed by driving one or two pieces of copper wire into each. To test the effects of copper wire six young trees from two to four inches in diameter were selected, and on March 21, 1919, there were driven into each tree five pieces of large copper wire 1.5 inches long. The end of each wire was left flush with the outer surface of bark. All wires were within six feet of the base of the tree. The trees comprised two hemlocks, two alders, one cedar, one willow.

On July 3, 1922 the trees were examined and found to be perfectly healthy. In all cases they had completely healed over the wires, and their growth was equal to that of other similar trees in the immediate vicinity. On cutting into the trees, it was found that there was very little injury to the wood, merely a brown color showing for about 1.5 inches above and below the wire, and about 0.25 inch to each side.

GEORGE B. RIGG

UNIVERSITY OF WASHINGTON

TANGENT LINES

OSGOOD and Graustein state in their *Analytic Geometry,* page 176: "A tangent to a conic might then be defined as the limiting position of a line having two points of intersection with the conic, when these points approach coincidence in a single point." This accords with the ancient idea of a tangent as touching a conic at only one point. That idea is given in a paragraph on page 163 of my *History of Mathematics,* from which Professor G. A. Miller quotes[1] part of a sentence and then criticizes that part. I illustrate this mode of criticizing by quoting from Professor Miller's review the following: "Students can usually prove a large number of theorems which they do not understand." Serious-minded readers would deny this statement, but when they read the whole sentence and the paragraph from which this fragment is taken, they will acquiesce.

FLORIAN CAJORI

SCIENTIFIC BOOKS

A Treatise on the Analysis of Spectra. By W. M. Hicks, Sc.D., F.R.S., emeritus professor of physics in the University of Sheffield, formerly fellow of St. John's College, Cambridge. Cambridge University Press, 1922, 231 pp. of text, 92 pp. of tables and 25 figures.

The purpose of the book is twofold, to serve as an introduction and handbook and to present the mature results of the author's extensive investigations. The treatise is based on an Adams prize essay presented in 1921. For the first purpose the appendix contains the Meggers and Peters tables for corrections to be added to the wave-lengths in air to reduce

[1] This Journal, October 13, page 421.

to vacuum, Rydberg's values of $N/(m + \mu)^2$, data for wave-lengths and wave-numbers of lines allocated to series, and the Hicks formula constants, in Chapter V in which he considers the effects of physical conditions, the various Zeeman patterns so far determined, illustrative of Preston's law, are collected for convenient reference and also the Stark data, and a table of radiation and ionization potentials is included.

Chapters II and III give a clear introduction to types of series and to the series systems now recognized in the different groups of the periodic table. In the following chapter Rydberg's rules are discussed in the light of the series systems now determined and of the available spectroscopic data. With the exception of the constancy of N, he considers that all the values are valid; as to N he concludes that we can not hope to determine exact values of N in the various series and elements from determination of formulæ constants alone, that it is practically certain that the value in general is larger than Rydberg's value and nearer Bohr's limit and that changes in N in the different sequences should not be unexpected.

A distinctive contribution by Hicks to the study of series is his modification of the Rydberg formula which he writes $n = A - N/(m + \mu + \alpha/m)^2$ where A is the limit, $\mu + \alpha/m$ the "mantissa," and N 109675 R. U. In his notation the separations from the limit in a series of lines form a "sequence" of values and a particular value is the mth "sequent." Separation is the difference in the wave-numbers of two lines, ν = doublet separation, Δ = the difference in the mantissæ of doublet sequences and is shown to be an integral multiple of the "oun."

The mantissæ play an important rôle in the author's development of the idea of the oun and "linkages." He writes $\Delta = m\ q\ w^2$ where m is an integer, q a universal constant, and w the atomic weight, which for convenience he divides by 100. From a consideration of the doublets of Ag he finds that q is 361.78.

The oun is considered to be a fundamental constituent in spectra and is written oun = δ, = $\frac{1}{4}\delta$ where $\delta = 361w^2$. The evidence given for the dependence of the oun on the square of the atomic weight is very strong, but the existence of isotopes introduces difficulties which the author recognizes but does not succeed in disposing of completely.

When a multiple of the oun is added to the limit mantissa, the modification is called displacement and a displaced line a "collateral." This leads to his theory of linkages, "that in certain elements the spark spectra consist almost wholly of long sets of lines differing from one another in succession by certain special separations which can be calculated from the ordinary series limits and Δ, these separations may be called links, and a complete set a linkage. These linkages appear to start from ordinary series lines." The subject of linkages is too complicated for presentation in a review; it aims to relate the lines which do not belong to the regular series to lines occurring in the ordinary series by a set of links. These links may occur in any order forming chains and meshes of lines. That "linkage spectra" represent realities and form a category coordinate with series and band spectra would seem to be a matter for further investigation.

The reviewer's impression is that the author over-estimates the accuracy of the spectroscopic data and one wonders whether with more accurate data the evidence for linkages would be increased or lessened. Professor Hicks is convinced that links occur with much greater frequency than a chance arrangement would suggest, but considers the most conclusive evidence to be furnished by the large number of regularities, repetitions, collocations of links and meshes. It is, however, somewhat surprising that lines in spark spectra should be related to each other by separations calculated from the limits and the Δ of the ordinary series inasmuch as spark spectra are characterized by their special types of series.

Chapters VIII and IX are devoted to a discussion of the distinguishing properties of the p and s and of the d and f sequences. For the p sequence the march of the mantissæ and atomic volumes is so close that he concludes that the p sequence depends directly on a quantity equivalent to the volume of the atom. On

the other hand the *d* and *f* sequents have as mantissæ multiples of the oun. The last two chapters are given to the monatomic gases and to the consideration of miscellaneous questions.

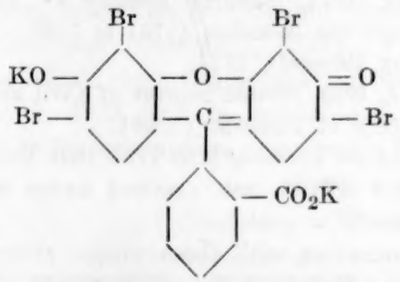
This book by Professor Hicks representing extensive researches for data and extended calculations based on the material collected and giving the views of one who has studied the subject so long and thoroughly will prove a welcome addition to a working library. It presents a general and connected view, provides a means of ready reference and suggests lines of investigation. It is well indexed and replete with references to original sources.

CHARLES E. ST. JOHN

AMERICAN EOSINS

IN a recent report of this committee[1] it was mentioned that a number of satisfactory samples of eosin had been obtained from American sources. At the time this early report was published no very definite data were at hand to show how these samples compared with samples of Grübler's eosin. At the present time, however, data have begun to accumulate giving a more satisfactory survey of the whole situation and it seems time to publish them.

Eosin is a compound of the phthalein series with a formula essentially as follows:



There are an almost innumerable number of different eosins on the market, differing slightly in chemical composition and having quite different staining properties and solubilities. They are usually classed in three or four groups denoted in Schultz's Farbstofftabellen, fifth edition, under the numbers 587, 588, 589 and 590.

Eosin 587 is the stain best known to the biologist. It is typically the same as the formula given above, namely the potassium salt of tetrabromfluorescein; but the monobrom and dibrom derivatives are also known, and as they sometimes occur mixed with the tetrabrom compound, the composition of this dye varies somewhat. Its color varies accordingly, because the more bromine atoms the bluer the shade. This dye is specified in the trade by such terms as eosin, yellowish eosin, eosin Y, and eosin G, water-soluble eosin, eosin W, eosin Y extra, eosin S extra.

Eosin 588 and 589 are both known as alcohol-soluble eosin, being only slightly soluble in water, but differ from each other in that 588 contains a methyl group in the place of one of the potassium atoms in the above formula while 589 contains an ethyl group in this same position. Number 588 is more correctly called methyl eosin while 589 is called eosin S or primrose.

Eosin 590 is a compound in which two of the bromine atoms have been replaced by NO_2-groups. This compound, like 587, is readily soluble in water but differs from it in its bluish color. It is known as bluish eosin, eosin B or eosin BN.

It must be understood that with such great variation in the possible composition, every manufacturer puts on the market a product slightly different from that of any other and as these compounds differ in shade each different product is generally known by its own trade designation. This gives the very confusing list of designations applied to eosin, of which those mentioned above are merely the commoner ones. It simplifies matters, however, if it is remembered that the terms eosin, yellowish eosin or water-soluble eosin refer to 587, while alcohol-soluble eosin refers to 588 or 589 and bluish eosin to 590.

No attempt was made in this work to get uniformity in the technic that was used, each collaborator being asked to use the samples for any purpose and according to any technic with which he was familiar. One of the investigators, in fact, reports five different tests to which he submitted the samples. As a result, these samples have been tested in a great

[1] Committee on Standardization of Stains: "Preliminary Report on American Biological Stains," SCIENCE, N. S., LVI, 156-160.

variety of ways and although it is hardly to be expected that the reports would be uniform under such conditions, it is felt, nevertheless that they have considerable value on account of the number of different methods by which the samples were tested. One of the collaborators tested the samples by the simple staining of bacteria; two used them for counterstaining in the Gram technic for staining bacteria. In three cases they have been tested in blood stains, in one case with hæmatoxylin, in another with methylen blue in the well-known Wright method, and in the third without combination with any other dye. Three of the investigators used the samples in tissue staining as a counter-stain against hæmatoxylin. One of the investigators, besides using the eosin in blood work and as a counterstain in the Gram technic, reports results obtained in staining cultures of *Penicillium*. These cultures after being killed and fixed were stained in mass, then mounted and examined. Lastly, another collaborator reports using the samples in two indicator media, one with brilliant green and the other with methylen blue.

The variety of these methods is sufficient so that there is good reason to feel that any sample which gave good results in all cases can be safely recommended. It was very clearly demonstrated that in the great variety of purposes for which these samples of eosin have been used, the American samples almost without exception are the best. Some may be slightly better than others for certain special purposes but there seems to be no reason for condemning any of them.

Satisfactory samples were obtained from the following American concerns: Eimer and Amend, Harmer Laboratories Company, Heller and Merz Company, N. Y. Color and Chemical Company, Providence Chemical Company, Darwin Chemical Company, Campbell and Company, Geigy Chemical Laboratory, Coleman and Bell Company, H. S. Laboratories, E. Leitz, National Aniline and Chemical Company Company and D. H. Pond.

The chairman of the committee is ready upon request to furnish investigators with information as to the apparent merits of each of these samples for particular purposes and as to how any particular one of these lots of eosin may be obtained.

Committee on Standardization of Biological Stains, National Research Council,

S. I. KORNHAUSER
F. W. MALLORY
F. G. NOVY
L. W. SHARP
H. J. CONN, *Chairman*

ZOOLOGICAL NOMENCLATURE

IN accordance with the provisions respecting the use of "plenary power" by the International Commission on Zoological Nomenclature, to suspend the rules in cases in which the application of the rules will produce more confusion than uniformity, the secretary has the honor herewith to notify the zoological profession that a proposition by Commissioner David Starr Jordan is now before the commission to suspend the rules in the following cases and to "definitely reject the works named below from consideration under the law of priority," namely:

Gronow, 1763, Museum Ichthyologicum.

Commerson (as footnotes in Lacépède Hist. nat. des Poissons, 1803 mostly).

Gesellschaft Schauplatz, 1775 to 1781. An anonymous dictionary accepting the pre-Linnæan genera of Klein.

Catesby, 1771, Natural History of Carolina, Florida and the Bahamas (1731 to 1750), revised reprint by Edwards, 1771.

Browne, 1789, revised reprint of Civil and Natural History of Jamaica (1766).

Valmont de Bomare, 1768-1775, Dict. Raisionnée Universelle d'Hist. nat. (several names accidentally binomial).

In connection with these works, attention is invited to Opinions Nos. 13, 20, 21, 23, 24, issued by the commission.

The effect of the foregoing proposition is to reject as unavailable (as of the dates in ques-

[1] Notice to zoologists (especially to ichthyologists) of Consideration of Suspension of Rules of Nomenclature in cases of Gronow (1763), Commerson (MS. names—quoted in footnotes in Lacépède, 1803 mostly), Gesellschaft Schauplatz (1775 to 1781), Catesby (1771 reprint by Edwards), Browne (1789), and Valmont de Bomare (1768 to 1775).

tion) all systematic (chiefly generic) names published as new in the foregoing works, but to leave them as *available* as of the dates when they were later adopted by authors whose nomenclatorial status is unquestioned by zoologists; thus, a *modus operandi* is suggested to solve in a practical way the impasse which has existed for about twenty years in the views respecting the use of the words "binary" and "binomial" and while neither side concedes the principle it supports, both sides unite on another principle, namely, that the important end in view is to obtain, not to delay, results, and that the "plenary power," used judiciously and discreetly, offers us a practical method to solve the problems upon which there is such conscientious difference of opinion as to interpretation that concensus of opinion seems hopeless.

The secretary is fully persuaded that the application of the rules to the foregoing publications will continue to result in greater confusion than uniformity and he proposes at the expiration of the proper time (one year) to recommend to the commission the adoption of Commissioner Jordan's proposition.

Zoologists interested in this proposition, *pro* or *con*, are cordially invited to present their views in writing to any member of the commission so that they can be given due consideration when this proposition comes to vote (approximately October 1, 1923). Views, *pro* or *con*, which reach the secretary prior to September 1, 1923, will be manifolded and submitted to the commission prior to the final vote.

C. W. STILES,
Secretary to Commission

SPECIAL ARTICLES

THE ORGANIZATION OF THE NERVOUS MECHANISM OF RESPIRATION

WE have been accumulating experimental data on the nervous mechanism of respiration for some years past, but these results have been for the most part presented in preliminary notes only.[1] Circumstances have arisen which make it seem probable that the publication of the full experimental data must be still further delayed. We wish, therefore, to present a brief summary of our general conclusions at this time.

Gad stated that the nervous mechanism of respiration extended from the facial nerve to the lumbar plexus. We must, in all probability, enlarge the field to include the fifth cranial nerve. Any statement of the organization of this mechanism must take account of all the pertinent elements found in this rather extensive region.

The primitive nervous mechanism for the control of respiratory movements in vertebrates has its central representation in the medulla oblongata. Against Trevan and Boock's view[2] of a primitive respiratory center in the region of the corpora quadrigemina we would say, (1) that we have no evidence of any cells in this region which are sensitive to carbon dioxide in the same sense that the central cells in the medulla oblongata are sensitive to it; and (2) since the corpora quadrigemina themselves are not primitive, it is difficult to see how such a primitive mechanism could be located there.

The activity of the central respiratory mechanism in the medulla is conditioned by (1) the concentration of substances dissolved in the blood, *e.g.*, carbon dioxide; (2) the temperature of the blood flowing through the medulla; (3) the volume of blood flowing through the medulla in unit time, and (4) afferent nerve impulses from various peripheral sensory fields. All these various conditions are summed algebraically in the central respiratory mechanism. This view implies an important extension of our common idea of the summation of stimuli.

The afferent nerve impulses arise, in higher mammals, *e.g.*, the cat, from the lungs and the

[1] Pike, F. H. and Coombs, H. C., *Soc. Ex. Biol. and Med.*, 1917, xv, 55; *Am. Journ. Physiol.*, 1918, xlv, 569; Coombs, H. C., *Am. Journ. Physiol.*, 1918, xlvi, 459; Pike, F. H., Coombs, H. C., and Hastings, A. B., *Soc. Ex. Biol. and Med.*, 1919, xvi, 49; *Am. Journ. Physiol.*, 1921, xlvii, 104; Pike, F. H. and Coombs, H. C., *Am. Journ. Physiol.*, 1922, lix, 472.

[2] Trevan, J. and Boock, E., *Journal of Physiology*, 1922, lv, 331-339.

respiratory epithelium generally, parts of the alimentary epithelium, the pleura, and the muscles of the thoracic wall, the diaphragm, and the abdominal muscles.

The afferent paths are (1) the vagus (tenth cranial nerve) from the lungs and trachea, the fifth cranial from the mucous membrane of the nose, the glossopharyngeal (ninth cranial) from the pharynx and the portions of the soft palate, the phrenic[3] from the diaphragm, the sympathetic[4] from the thoracic wall, and the dorsal roots of the spinal nerves from the thoracic and abdominal muscles.

The central connections of the vagus do not necessarily extend beyond the medulla oblongata. The central connection of the spinal tracts arising from dorsal root fibers are primarily with the mid-brain (region of the corpora quadrigemina) and only secondarily with the medulla oblongata.

We have no evidence of any true respiratory mechanisms of an accessory sort in the spinal cord. The efferent root cells in the spinal cord have no special sensitiveness to carbon dioxide.

The respiratory rate becomes slower after division of both vagi for the reason that afferent impulses over the vagi, which are normally summed with the carbon dioxide in the blood to produce an excitation of the cells of the medulla, are no longer present, and the excitation of the central cells is now dependent in large part upon the carbon dioxide alone. The form of the respiratory movements changes for the same reason that the movements of a limb undergo a change in character when the afferent nerves from the limb are divided, *i.e.*, both types of movements become ataxic.

A further fall in the respiratory rate ensues when, in addition to division of the vagi, there is section of the dorsal roots of the spinal nerves or transection at the lower border of the midbrain because there is a still greater loss of afferent nerve impulses, and excitation of the efferent cells in the medulla oblongata becomes almost wholly dependent upon the carbon dioxide of the blood. The respiratory movements also become correspondingly more ataxic.

Costal movements of respiration fail after section of the dorsal roots alone for the reason that the efferent root cells of the intercostal nerves, which are normally excited by impulses from at least two sources—the descending respiratory motor fibers and the dorsal roots of the intercostal nerves—now receive impulses from the descending fibers only. There is no actual paralysis of the efferent root cells, since costal movements are immediately resumed when contraction of the diaphragm is prevented. This indicates that von Monakow's diaschisis effect is due to loss of some nervous impulses normally entering into the process of excitation of a motor cell.

Our idea of the manner of action of the nervous mechanism for respiration may be briefly stated as follows. Afferent impulses passing into the central mechanism in the medulla oblongata reach the efferent cells through connections which do not pass outside of the medulla itself. The central pathways of afferent impulses over the sympathetic fibers and the phrenics are at present unknown. Afferent impulses coming in over the dorsal roots of the spinal nerves reach the efferent root cells through intra-spinal connections, but the discharge of these cells is withheld until the arrival of impulses over the descending tracts in the spinal cord. Impulses from these two sources are summed in the excitation of the efferent root cells. Other impulses from the dorsal root fibers pass up the spinal cord to the region of the corpora quadrigemina, but whether over the ventral spino-thalamic fibers[5] or over fibers in the spino-cerebellar tracts is uncertain. From the midbrain, these impulses are relayed to the cells of the respiratory center in the medulla oblongata. The excitation of these cells is dependent upon the summation of stimuli arising from (1) the concentration of carbon dioxide in the blood flowing through these cells, and (2) the nervous impulses coming in over the various afferent pathways. The

[3] Mathison, G. C., *Review of Neurol. and Psychiatry*, 1912, x, 553.

[4] Barry, D. T., *Journ. Physiol.*, 1912, xlv, 473.

[5] Ransom, The Anatomy of the Nervous System, Philadelphia, 1920, p. 104.

afferent nerves thus have the double function of (1) contributing to the excitation of the cells in the respiratory center, and (2) of controlling the movements of the muscles arising from this excitation. While it is undoubtedly true that the respiratory center may act automatically under conditions which preclude the effect of afferent impulses[6] it is our opinion that its normal activity is not wholly automatic but partly reflex.

F. H. PIKE
HELEN C. COOMBS
COLUMBIA UNIVERSITY

THE AMERICAN CHEMICAL SOCIETY

(Continued)

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY. II

The application of certain commercial dyes to the reductase test on milk: MINNIE F. DRESSLAR and H. A. WEBB. The decolorization of methylene blue by the reductases in milk furnishes a rapid approximate determination of its bacterial age. In order to make the test more convenient for bakers, grocers, restaurant keepers, cooking classes or housewives, who might wish to test milk claimed to be fresh on delivery, eighty-four dyestuffs sold under trade names for household use were tested. By a series of eliminations, the most satisfactory ones were determined, eight in number. They are: "Diamond Dyes" (wool and silk), cardinal, garnet, orange, turkey red; "Rit" dyes, blue, flesh, lavender, red. The decolorization times, which vary for each, but are reasonable, and the effect on various types of milk-whole, skimmer, cream, pasteurized, boiled, malted, condensed, evaporated, were determined. Suggestions for the use of the test by non-technical people are given.

Data on the thickening of condensed milk: ALAN LEIGHTON and COURTLAND S. MUDGE.

Use of frozen eggs in mayonnaise: S. K. ROBINSON. Comparisons between the fresh and frozen eggs were made on batches of mayonnaise. No difference in the product was noticeable, immediately after preparation. Both products were well emulsified and had good body. The following physical tests were then applied: microscopical examination, freezing test, incubation, shaking test and effect of air and light. Not any of these tests put the frozen egg product at a disadvantage. Mayonnaise made from frozen eggs held well in a warm room for thirty days.

Changes in hens' eggs stored in water glass and in lime solutions: F. C. COOK and J. B. WILSON. Strictly fresh and commercial eggs, which were preserved in water glass (1-10, 1-13 and 1-20) and saturated lime solutions. Separate jars of each were stored in the laboratory and in a cellar. At the beginning of the experiment and after various periods samples of the eggs were examined physically, bacteriologically and chemically. Best results were obtained by holding strictly fresh eggs in a 1-10 water glass solution at cellar temperature. Changes of considerable magnitude were found in water, ash and nitrogen contents of both whites and yolks. Bacteria were not found to be a factor in deterioration. Ammonia nitrogen and acidity of fat proved to be the best indices of decomposition.

Manganese, aluminium and iron ratio as related to soil toxicity: R. H. CARR and P. H. BREWER. Much emphasis has been given in the past to the isolation of organic toxins which were thought to be the cause of soil toxicity, while in more recent times the trend of investigation has been turned more specifically to soil acidity as the reason for poor crop yield. Investigations which have been conducted on a large variety of soils using the potassium thiocyanate method for soil acidity and toxicity, described by one of the writers, indicates that the cause of infertility of many soils, supplied with sufficient plant food, is due to the presence of soluble manganese compounds in some cases, to aluminum compounds in other instances and sometimes to a combination of the two. The toxicity of soluble iron is not so apparent, as it is usually associated with a considerable quantity of soluble aluminum in an acid soil. The potassium thiocyanate method has been found helpful in this study, because of the color changes taking place when these elements are present in the soil in easily soluble form. If the soil is more acid than p_H 5.5 a red color of ferric thiocyanate is produced in the presence of soluble ferric iron and if this soil solution containing manganese is made slightly more basic, a green color will develop in the liquor. The depth of the color will be proportional to the amount of manganese in the soil solution. This color begins to form when the soil contains about 0.008 per cent. of soluble manganese. The green color will be found associated with nonproductive acid soils, and since it is shown that manganese does not precipitate as a hydroxide until a p_H of about 7.9 is reached,

[6] Stewart, G. N., and Pike, F. H., *Am. Journ. Physiol.*, 1907, xix, 328.

a large amount of limestone (8 to 10 tons in addition to that required to remove the red color) will be required. In some instances the cost of this large amount may be prohibitive.

The effect of selenium compounds upon the growth and germination of plants: VICTOR E. LEVINE. The findings of Gassmann (*zs. Physiol-Chem.*, 1917, 100, 209) that selenium is a constituent of plants has led to the inquiry as to the effect of selenium compounds upon germination and growth. White lupine and timothy seedlings were used in the experiments. Concentrations of 0.001 per cent. to 0.0001 per cent. show no injurious effect; in some experiments these concentrations favor growth. Concentrations of 0.01 per cent. and over are exceedingly inimical to germination and to growth. The compounds may be arranged as follows in the order of diminishing toxicity: selenious acid, selenic acid, sodium selenite, sodium selenate and potassium selenocyanate. This order agrees well with that obtained with animal experiments testing the relative toxicity of these compounds. It is evident from the results obtained that selenium can not replace sulfur in the nutrition of plants.

The determination of nitric nitrogen in the soil solution: WALTER THOMAS. The determination of nitric nitrogen is the *bête noir* of the soils chemist. Inasmuch as the phenoldisulfonic acid method is the one that is the simplest and most rapid, and therefore more generally used by soil chemists than any other, the author has carried out some experiments on the effect of various flocculating and clarifying agents under carefully controlled conditions by this method and compared the results with the Devarda reduction method, which is the only one that has escaped serious criticism. The results obtained by different investigators have been very conflicting, but the results of the present investigation indicate that: (1) The use of either potash alum or alumina cream (even if neutral) results in large losses of NO_3; (2) CaO if freshly ignited is the most satisfactory flocculating and clarifying agent; (3) The Devarda alloy method gives excellent results on the soil solution, but is not applicable to rapid routine work.

DIVISION OF FERTILIZER CHEMISTRY

F. B. Carpenter, *chairman*

H. C. Moore, *secretary*

Water-soluble nitrogen in mixed fertilizers: R. N. BRACKETT.

Studies on the availability of organic nitrogenous compounds: C. S. ROBINSON.

Review of methods of determining nitrogen in fertilizer: E. W. MAGRUDER.

Possibilities in the use and preparation of concentrated fertilizers: WILLIAM H. ROSS. The Haber and other processes for fixing nitrogen and the volatilization method of preparing phosphoric acid all yield materials, directly or by combination, of different composition and higher concentration than those ordinarily used in the manufacture of fertilizers. Some of these materials, as ammonium phosphate, have chemical and physical properties which make them admirably suited for mixing with ordinary fertilizer materials, or for making mixed fertilizers of higher concentration than any now in use. Others, as ammonium nitrate, can not be satisfactorily used in present fertilizer mixtures unless means can be devised for eliminating or neutralizing properties which interfere with their use in this way. The work of the Bureau of Soils on concentrated fertilizers and fertilizer materials was therefore undertaken not with a view to replacing the ordinary fertilizer materials, nor of providing high quality fertilizers which would command higher prices per unit, but rather with the double purpose of devising means of utilizing new sources of fertilizer materials and of decreasing the cost of handling and transporting fertilizers by increasing the concentration of mixtures which require shipment to a distance. The advantages and disadvantages of low-grade fertilizer mixtures are discussed and a review given of progress made in the preparation of concentrated fertilizer materials.

Recent investigations on the oxidation of sulfur by micro-organisms: J. G. LIPMAN. There has been isolated at the New Jersey Agricultural Experiment Station a new sulfur-oxidizing organism which has been named *Thiobacillus thioxidans.* This organism grows readily in purely inorganic media containing, aside from the usual mineral salts, elementary sulfur. It derives its energy from the oxidation of sulfur and obtains its carbon from carbon dioxide. It will grow readily in a medium having a hydrogen-ion concentration of 4.0 to 5.0 and will continue to multiply when the hydrogen-ion concentration exponent is below 1.0. The sulfur is oxidized by this organism to sulfuric acid. The acid so produced may be utilized for a variety of purposes. Mixtures of mineral phosphates and sulfur, properly inoculated with *Thiobacillus thioxidans,* will be converted into acid phosphate. Inoculated sulfur added to the soil will increase its acidity to a point where certain objectionable fungi, like those

producing scab of potatoes and scurf of sweet potatoes, may be largely if not entirely suppressed. The transformation of sodium carbonate, present in excessive amounts in so-called black alkali soils, into sodium sulfate may be similarly accomplished. The direct use of inoculated sulfur for the purpose of supplying sulfates where these may be present in inadequate amounts, or the use of the same material for the production of potassium sulfate from greensand marl is indicated. The elimination of soil-infesting insects, or nematodes and of undesirable vegetation may also be accomplished by means of sulfur inoculated with cultures of *Thiobacillus thioxidans*.

Trend of modern fertilizer plant construction: PETER S. GILCHRIST. This paper will deal with the construction features of up-to-date fertilizer plants, including types of buildings, materials for building construction, equipment for plants and the relation of equipment to the building. Especial attention will be given to the design of plants with the necessary equipment for the economical handling of materials, silos or storage bins for storing phosphate rock, air separation for ground rock, the development of mechanical dens for making acid phosphate and economical methods of manipulating and bagging finished goods.

Modern trend in fertilizer plant operation: E. H. ARMSTRONG. The manufacture of sulfuric acid as the basis of the fertilizer industry. A brief résumé of this subject, giving developments from its inception to the present time. A brief discussion of the present methods pursued in operating a modern sulfuric acid plant. A short discussion of the developments in acid phosphate manufacture, together with a review of the more modern methods and the trend toward finer grinding, emphasizing the necessity for close chemical control. A comparison of the old and new ways of mixing fertilizer, showing the tendency towards larger mixing units and a better conception of the necessity for more methodical sampling and for coordination between operating and analytical departments to insure closer analyses.

Modern trend of chemical control in the fertilizer industry: H. C. MOORE. Chemical control involves the practical application of chemical phenomena and laws to the manufacturing operation, thereby directing or restraining influences as conditions require. Chemical control is not chemical analyses alone, but is the sum total of chemical analyses, chemical knowledge and practical experience and the correlation and application of these with the problems at hand. Chemical control has pointed the way to remarkable economy in the manufacture of sulfuric acid; to economic progress and a greatly improved product in the manufacture of acid phosphate; and to the cost, mechanical condition and quality in the manufacture of mixed fertilizers. The modern trend of chemical control in the fertilizer industry is to substitute knowing for guessing; to learn the best working conditions for each type of plant, and the materials and mixtures it is required to use or make; to determine the best and most economical combinations of materials to be used in the manufacture of fertilizer; to determine the best methods of formulating and using the materials so selected; to determine the general crop needs and materials most suitable for supplying it; to determine the combination of materials which must be avoided or if possible to see how this may best be done; to determine the best means of avoiding large unit losses of materials, of preventing analytical discrepancies and of sampling all products to insure reliable analytical results. Thus chemical control properly becomes both the governor and safety valve on the whole machinery of the fertilizer industry.

Modern trend in state fertilizer control: ANDREW J. PATTEN.

Modern trend in fertilizer legislation: J. E. BRECKENRIDGE.

Modern trend in fertilizer experimentation: DR. H. J. WHEELER. Fertilizer experiments at Rothamsted on permanent meadows, at Rhode Island on limed and unlimed soils and with different phosphates and potash salts, coupled with similar experience elsewhere, and the studies of lime-magnesia ratios, of the different effects of iron, magnesia and of manganese, boron, strontium, barium, lithium and other elements not usually considered plant foods have shown the necessity for intensive study of the physical, chemical and biological conditions best adapted to each kind of plant. At the same time, the relation of soil colloids to problems of fertilization and plant nutrition has been especially emphasized. Future investigators will study thoroughly physical and biological soil properties as related to fertilization, correlating them more closely than before with individual plant requirements and adaptations.

The determination of potash in mixed fertilizers: F. B. CARPENTER. A brief review of the methods for the determination of potash in mixed fertilizers prior to the adoption of the Lindo-

Gladding method as official by the Association of Official Agricultural Chemists, with modifications which have been made since. The official method, although popular with analysts, gives low results and suggestions are made as to modifications, which may be used to recover all the available potash. It is recommended that the fertilizer division take up the matter and work out an accurate method, which will be acceptable to the Association of Official Agricultural Chemists.

Some sources of error in the determination of insoluble phosphoric acid in acid phosphate and fertilizers: W. R. AUSTIN.

Some sources of error in the determination of total phosphoric acid in acid phosphate and fertilizers: W. R. AUSTIN.

A qualitative scheme for the detection of cyanamide and related compounds: G. H. BUCHANAN. Quantitative methods for the determination of cyanamide and its transformation products are only of value when preceded by a reliable qualitative examination. A qualitative scheme is presented, modeled after the ordinary schemes of inorganic analysis, whereby ten forms of nitrogen which are commercially related to cyanamide may be detected. Provision is made for the interference of the more common inorganic radicles. The ten forms included in the scheme are as follows: (1) Ammonia and its salts; (2) Cyanamide; (3) Hydrocyanic acid and its salts; (4) Dicyandiamide; (5) Guanidine and its salts; (6) Quanylurea and its salts; (7) Nitric acid and its salts; (8) Thiocyanic acid and its salts; (9) Thiourea; (10) Urea. Comments relating to the behavior of several other less common nitrogenous forms are also made.

The importance of correct methods of applying fertilizer: E. J. PRANKE. Faulty methods of applying fertilizer in the seed row in direct contact with the seed frequently causes visible damage to the crops, for which the grower often seeks to recover compensation from the fertilizer manufacturers. There is probably also a great deal of invisible damage caused by improper method of applying fertilizer. The effect of the relative position of seed and fertilizer on the efficiency of the latter, as developed in extensive researches conducted during the past three or four years, is discussed.

Fertilization in relation to plant composition: H. A. NOYES. Mention was made of different methods of testing the fertilizer requirements of soils. A study of these methods showed that the users of fertilizers measure results, almost entirely, on the increases in the marketable portions of the crop grown. There are many reports of increased crops resulting from fertilization but very little information of the character and composition of the plants. Industries which manufacture food-stuffs from grains and fruits find the control of their finished products difficult, due *to immense variations in the composition of the grains and fruits which serve as their raw materials.* Data was presented showing that large variations exist in the composition of two economic plants. A plea was made for a study of the optimum analyses for each economic agricultural crop. Such a study would cause fertilizer results to be judged in terms of variations toward or away from the optimum analyses. As a result of a long series of investigations of one crop under field conditions the following hypothesis was evolved. *When the optimum composition for any two parts of a plant is worked out it will be possible to determine how to fertilize the soil by studying the ratio that exists between the analysis of the different portions of the plant.*

Replacement of plant food adsorbed by the hydrogels of ferric oxide and alumina: A. L. FLENNER, A. L. LICHTENWALNER and N. E. GORDON. The hydrogels of ferric oxide and alumina were allowed to suffer their maximum adsorption of salts. When this equilibrium had been reached the gels were subjected to successive washings with distilled water, and when 50 cc. of the filtrate failed to give more than a very slight test for the adsorbed salt, the gel was subjected to washings with various acid, base and salt solutions, and the resulting filtrates analyzed for the respective salts. Analysis of the gel was made at each change of the leaching solution.

Can plants use salts adsorbed by soil colloids: R. C. WILEY and N. E. GORDON. Experimental work was started in order to find if plants were able to use salts which had been adsorbed by soil colloids. The soil colloids were artificially prepared, and after they had suffered a maximum adsorption of the various salts used in plant nutrition work, the plants were allowed to root and grow in the colloids. After a certain period of growth the plants were analyzed for the quantity of different elements which the plants had been able to take up from the colloids.

Utilization of waste products for organic nitrogen: E. H. ARMSTRONG. The comparative abundance of materials carrying organic nitrogen in available form which were to be had in the early stages of the fertilizer industry; the gradual withdrawal of these from the fertilizer materials market to the feed market; the use of part min-

eral ammoniates and part organic ammoniates to offset this shortage; the necessity of conserving all waste materials carrying organic nitrogen and of developing methods to render available the nitrogen in such inert materials as leather, hair, etc.; a description of the manufacture of leather meal, its undesirability and a comparison of the European and American products; a refutation of the general understanding that the nitrogen in the inert materials can not be made soluble without loss of ammonia, and the reference to a high class product which can be used in any quantity; a discussion of garbage tankage and other waste.

DIVISION OF PETROLEUM CHEMISTRY

T. G. Delbridge, *chairman*

W. A. Gruse, *secretary*

The vapor pressure of solutions of benzol, hexane and cyclohexane in lubricating, gas absorbent and vegetable oils, with molecular weight data: ROBERT B. WILSON and EDWARD P. WYLDE. A knowledge of the vapor pressure of volatile solvents, such as benzol and hexane, dissolved in various types of relatively non-volatile oils, is of commercial importance in a considerable number of applications. Of these the three most important are (*a*) the dilution of crank-case oils with fuels in internal combustion engines; (*b*) the complete removal of volatile solvents from oils and fats obtained by the solvent extraction processes; and (*c*) the recovery of solvents by scrubbing with cold absorbent oils, as in benzol recovery from coal gas. It was the object of the work described in this paper to make possible such generalizations and approximate calculations for the three general types of volatile hydrocarbons—paraffin, napthene, and aromatic—dissolved in most ordinary types of oils. Molecular weights were determined on all of the oils used, and the amount of vapor pressure lowering for different combinations was compared with the theoretical as predicted by Raoult's law. It appears that the amount of lowering produced by different types of combinations is fairly definitely predictable and that the results for any combination met with in practice can be calculated with quite satisfactory accuracy for any ordinary temperature if the vapor pressure of the pure volatile constituent is accurately known, together with the molecular weight and type of hydrocarbons present in the oil. Molecular weight data included in the article is also of interest in being the first published data on a fairly wide range of the higher mineral oil fractions, the results having been obtained by measuring the freezing point lowering in benzol.

Further data on the measurement of the effective volatility of motor fuels: ROBERT E. WILSON and DANIEL P. BARNARD, 4th. This paper is an extension of the work presented at the Rochester Section where some new methods of determining the effective volatility were described and the results on three typical fuels presented in some detail. This work has been extended to more than a dozen fuels in this laboratory and this, combined with data obtained in other laboratories, makes it possible to draw certain generalizations as to the effect of the shape of the distillation curve on the effective volatility of the fuel in so far as it affects the completeness of vaporization and proper distribution in the manifold. In the light of these investigations, the writers believe that a single specification for the 85 per cent. point should replace all the present limitations at 50, 90 and 96 per cent., and, similarly, that the effective starting volatility can best be measured as a routine proposition by a specification at the 25 per cent. point rather than at the 5 per cent. or initial point.

Some applications of vapor pressure measurements: HAROLD S. DAVIS. An improved differential-pressure apparatus for measuring vapor pressure is described. The apparatus can be successfully applied to the control of light oil recovery plants. Actual data from plant tests are given. It has been suggested that oils could be standardized for efficiency in gas absorption by preparing solutions containing the same concentration of benzene and measuring their vapor tensions. Experiments on seven representative absorbent oils have shown no appreciable differences between them in this respect, and practical variations in their efficiencies must be attributed to other factors rather than to their ability to lower the vapor tensions of dissolved benzene. Some applications of vapor pressure measurements in gasoline recovery are discussed.

A rapid test for the decolorizing efficiency of fuller's earth: LEON W. PARSONS and LEONARD R. CHURCHILL. The paper covers the development of a rapid test for determining the relative efficiencies of various samples of fuller's earth for decolorizing purposes. This test was desired to avoid the necessity for resorting to tedious filtration processes in the laboratory to determine the quality of the clay, and it serves two purposes: first, to compare the decolorizing power of various clays used in experimental investigations; and second, to serve as a rapid control test for plant operation. A survey of the properties of fuller's earth which would parallel its power to

decolorize oils is given and the development of several different tests is indicated. The most satisfactory test, however, is based on the reaction between fuller's earth and pinene. Fuller's earth reacts vigorously with pinene to form polymerized products with the development of a very large amount of heat. The amount of temperature rise is used as a measure of the efficiency of the clays and data is given to show the relation between this pinene efficiency and the decolorizing power of such clays. A discussion of the mechanism of the reaction, the materials used and the application of the test for laboratory and plant use is indicated.

Effect of certain physical and chemical properties of emulsifying agents on the stability of oil-water emulsions: LEON W. PARSONS and BRIAN MEAD. This paper embodies further studies on Nujol-water emulsions and a comparison of these systems and commercial mineral oil emulsions. The technique of investigating these emulsions, making use of microphotographic apparatus and the ultra-microscope, is given. A study has been made of the following factors of extreme importance in connection with the stability of emulsions: Physical characteristics of emulsifying agents; effect of opposing emulsifying agents in the same system; action of oil soluble colloids on the emulsifying agents; and similarity between behavior of soaps and of finely divided solids. The importance of relative wetting of the different phases by the emulsifying agent is emphasized and it has been found that several common emulsifying agents give abnormal results with regard to type of emulsions produced. This latter observation has important bearing on the mechanism of the behavior of soaps and finely divided solids as emulsifying agents. Certain parallelisms have been observed between the behavior of the emulsifying agents used for Nujol-water systems and those present in commercial oil emulsions.

Engine experiment with high sulfur fuels: CARL O. JOHNS. These experiments were conducted by Professor George Winchester, formerly in charge of the Engine Research Laboratory of the Standard Oil Company of New Jersey. A Hvid type of Diesel engine ("Thermoil") was used. Several fuels were tested to ascertain the effect of both free and organic sulfur. The runs were continued for 384 hours. The fuels included high sulfur Mexican crude and gas oil, and mixtures of these with a polymer oil containing about 19 per cent. of combined sulfur, or 10 per cent. of sulfur in the mixed fuel. The running time for these fuels was 180 hours. The compression in the engine reached 500 pounds. A run of 204 hours duration was made with kerosene containing 0.85 per cent. of free sulfur in solution. Frequent examinations of the dismantled engine disclosed no evidences of corrosion, nor was the copper tubing affected appreciably. Trouble was encountered by the excessive formation of carbon which deposited on the exhaust valve and clogged the spray holes to the cylinders.

Gasoline saved on government trucks due to adjusting the carburetors by gas analysis: G. W. JONES and A. O. FIELDNER. Carburetor adjustments by exhaust gas analysis on 15 trucks, varying from 2½ to 7½ tons capacity, showed that all but one were too richly adjusted for maximum power and economy. The adjustments made gave an increase of over 20 per cent. in mileage for the first month after testing and 16 per cent. increase for the second month. The CO_2 indicator used for making the adjustments while the trucks were operated was found to be practical and easily operated by the laymen inexperienced in the handling of chemical apparatus. An analysis of the exhaust gas under the conditions which the truck is operated gives an absolute indication of the carburetor adjustment and removes all guess-work. By adjustment for maximum power and economy is meant the leanest adjustment without reduction of power.

Some factors affecting the accuracy of Saybolt viscosity measurement and their control: P. E. KLOPSTEG and W. H. STANNARD. Without a suitable form of automatic temperature control, it is impossible to secure experimental conditions which conform to A. S. T. M. specifications, namely, that "the bath shall be held constant within 0.25° F. (0.14° C) at such a temperature as will maintain the desired temperature in the standard oil tube." At any rate, the requirements can not be met with the form of bath described in the specifications. In this paper, the development is described of an electric heating and regulating device which at a temperature of 212° F. (100° C.) will hold the bath temperature constant within 0.1° F. (.05° C.) throughout an entire day's run without attention. Conditions within the oil tube are also considered, and it is shown that when the A. S. T. M. method of stirring is followed, even with the bath temperature very constant at 212° F., variations of 0.5° F. are observable on a sufficiently sensitive stirring thermometer. A method of stirring is

then described by means of which it was found possible to hold the temperature of the sample under test constant to 0.01° F. over a period of many minutes. Tabulated data show the Saybolt readings at different temperatures, for samples tested under "standard" conditions, and with the new apparatus.

Cracking of unsaturated hydrocarbons by heat to give saturated hydrocarbons: RALPH H. MCKEE and RALPH T. GOODWIN. The real liquid fuel reserve of America is in its oil shale deposits. In a study of oil shale we have found that distillation in vacuum gives an intermediate product which on heating gives over into petroleum. A study of this intermediate from various oil shales shows it always to be highly unsaturated (dissolved by 66° Be sulfuric), sometimes 100 per cent. unsaturated. If this waxy intermediate is distilled at atmospheric pressure, there is obtained a petroleum containing 48 per cent. saturated hydrocarbons. Redistillation brings about additional cracking with a further increase of the percentage of saturated hydrocarbons. Ordinarily we expect the cracking of hydrocarbons to proceed with increase of unsaturated constituents but here we have the reverse, the unsaturated constituents decreased 48 per cent. on the first distillation and still more on redistillation.

The refining of gasoline and kerosene by hypochlorite solutions: A. E. DUNSTAN and B. T. BROOKS. The present paper is a description of the process developed and perfected by A. E. Dunstan and his associates in the Anglo-Persian Oil Company. It is the first successful industrial utilization of hypochlorite solution for refining of petroleum oils. Gasoline and kerosene may be refined in this way with treating losses of less than one half of one per cent. Malodorous compounds, including sulfur derivatives, are removed. The treated oil is free from chlorine, is free from substances which develop acidity, gummy substances or discolorations on standing, and it eliminates obnoxious waste products, such as acid tar, eliminates acid recovery and the process can be carried out in the usual form of treating apparatus. The new method, therefore, is cleaner and easier to operate, gives a much better refined product, and the refining costs are markedly lower, particularly when the losses incidental to sulfuric acid refining are included in the comparison. The process is particularly adapted to light distillates from high sulfur crudes and the savings are greatest in the case of cracked gasolines.

Refining of cracked hydrocarbon oils: JACQUE C. MORRELL and GUSTAV EGLOFF. The various methods of refining light petroleum distillates are discussed. The general methods involved are (*a*) physical and (*b*) chemical. The physical method of refining involving the use of various adsorbent earths, though giving good results, can not compete commercially with the chemical methods of refining. The chief chemical method in use to-day is the sulfuric acid method of refining, and it is the use of various modifications of this method upon which the authors lay the greatest stress. Applying various modifications of this method with regard to subsequent treatment as well as concentration and amounts of reagents, the authors have successfully refined cracked distillates from the following raw materials and have produced water white gasoline of sweet odor, as well as a product which will pass the corrosion and doctor test: (*a*) California gas oil, (*b*) Midcontinent fuel oil, (*c*) Midcontinent gas oil, (*d*) Mexican gas oil, (*e*) Texas fuel oil. The raw oils were cracked on a commercial scale in the gas-liquid phase. The authors describe in detail the methods used with full discussion of the theories involved, especial stress being laid upon the treatment of hydrocarbons containing sulfur compounds. The effect of the sulfuric acid treatment upon the unsaturate per cent. is also discussed. It is concluded that following the methods and principles laid down by the authors, all types of cracked hydrocarbons, regardless of the type of raw oil used to produce them, can be successfully treated to produce water-white products of sweet odor.

Fractional distillation of various petroleums under reduced pressure with new type receiver: JACQUE C. MORRELL and GUSTAV EGLOFF. A new type of receiver for fractional distillation under reduced pressure is described. The general principles and elements of the receiver are as follows: The receiver is made up of two graduated chambers, the whole being arranged so that it can be properly mounted. These chambers are connected by a stop-cock. The arrangement is such that one fraction may be drawn off from the lower chamber, while the next fraction is being distilled in the upper chamber. The rate of distillation is always under perfect control. With regard to the fractional distillation of petroleums under reduced pressure, following a general discussion of the theory and experimental method, comparative distillation of the following crude oils, under atmospheric distillation and vacuum distillation, are shown: Kentucky crude, Arkansas crude, Colorado crude, Ohio crude, California crude, Texas crude and Mexican crude. A dis-

cussion of the results from the viewpoint of unsaturate content, percentage of paraffin and viscosity of lubricating stock for both types of distillation follows the experimental results.

Sulfo-acid bodies in lubricating oils: G. L. OLIENSIS. When lubricating oils are overtreated or prematurely neutralized in the agitator, some sulfo-acid compounds from the sludge are re-incorporated in the oil. The breaking of the resultant emulsion or blowing of the oil to brightness causes some of these compounds to go into perfect solution in the oil. The Conradson Demulsibility and Vacuum Company steam tests then cause these bodies to precipitate as a soapy layer below the oil, thus constituting qualitative tests for such material. Evidence indicates that a foamy layer differs from a homogeneous layer only in concentration. It is indicated that this layer is caused by salts of inorganic acids, etc. The significance of the presence of such material and the usefulness of the Conradson test for its recognition are discussed.

Calculations of flash points: EDWARD MACK, CECIL E. BOORD and HAROLD N. BARHAM.

SYMPOSIUM ON "LUBRICATION FROM THE CHEMISTS' VIEWPOINT"

Lubricant and asphaltic hydrocarbons in petroleum: C. F. MABERY. The work of this paper is a continuation and expansion of the preliminary notice presented at the Rochester meeting, in which it was stated that an investigation had been begun to ascertain the composition of the part of petroleum that can not be distilled without decomposition. This work is now well advanced and a large number of hydrocarbons have been identified in typical West Virginia, Pennsylvania, Mecca, Texas and Baku oils. The more soluble lubricant hydrocarbons, at least those of lower molecular weight, collect for the greater part in the D series (more soluble) and the heavier asphalts in the H series (less soluble). The two series differ widely in viscosity and in lubricant quality. Tested on a fractional machine, the D's are superior in wearing quality to the H's. The highest viscosity is shown by the Mecca D No. 8, the last one of the series, $C_{78}H_{138}$, 5461 seconds, in an Ostwald tube, water standard 0.25 S. at 38 C., 100° F., 2780 Saybolt. This paper also gives tables of viscosity, iodine numbers, showing unsaturated hydrocarbons and values by the formolite reaction showing internal cyclic unsaturation.

Viscosity temperature curves of fractions of typical American crude oils (Second paper): F. W. LANE and E. W. DEAN.

Low speed-high pressure friction tests with a Kingsbury machine: W. F. FARACHER and RONALD REAMER. A discussion is given of data on frictional coefficients obtained with a Kingsbury oil-testing machine in which speed was maintained at 7.4 feet per minute and pressure was varied over the range of 2,000-4,000 pounds per square inch. A number of mineral oils and several compounded lubricants were studied.

A graphical study of journal lubrication: H. A. S. HOWARTH. This study is based on W. J. Harrison's paper, "The hydrodynamic theory of lubrication." The oil pressures and friction are represented quantitatively by simple diagrams showing the effects of varying the speed, oil viscosity, eccentricity and clearance. A few examples are given showing the practical application of this study to the case of a journal surrounded by the bearing.

The mechanism of partial lubrication: R. E. WILSON. This subject is presented from the standpoint of the author's recently published papers on the subject, and some additional material is brought forward.

Notes on the chemical composition of mineral lubricating oils: A. DUSTON and THOLE.

The origin of petroleum—origin, migration and accumulation of oil and gas: R. E. SOMERS. The inorganic theories of origin, such as that of Mendeleef, are geologically impossible for large amounts of oil and gas. The organic theories better account for the commercial pools. Effects of geologic alteration continue beyond the first formation of oil and gas and, according to White's laws, lighter fractions are added with increasing pressure and longer time. The geologically older oils are lighter in weight and the younger are heavier. Oil passes from the source bed shales into the reservoirs because of compacting of the shales, and perhaps because of a differential capillarity. Accumulation into pools starts when the reservoirs are loose and uncemented, and is then due principally to differences in specific gravity between oil, gas and water. It continues as the reservoirs become cemented, but gravitation is either assisted by other influences, such as gas pressure, or else replaced by capillarity.

The probable mother substance of petroleum: REINHARDT THIESSEN.

CHARLES L. PARSONS,
Secretary